INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE

for Northern Ontario
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Conference Proceedings

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INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE

FOR NORTHERN ONTARIO

October 15-17, 1990
Sault Ste. Marie, Ontario

PROCEEDINGS

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INTRODUCTION

It is with great pleasure that I introduce this edition of the proceedings of the second Innovative Technology Transfer Conference for Northern Ontario. That it is ready for you, the conferee and the reader at the time of the conference and not some time afterward (as was the case at the first conference) is due not only to the professionalism and commitment of the contributors, but to Mike Moselhy who selflessly put it all together and to Carey Thompson who provided the finishing touches and got it published with her usual charming efficiency.

The contents of these proceedings echoes the time we live in. How do we begin to solve the vast problems, both locally and globally, that endanger environmental sustainability? Will those magic words "Sustainable Development" save us? What, in fact, do they mean to us in our homes, at our workplaces, or in the political forum? The contributors to these proceedings have placed some innovative ideas before you and some have described their actual experience in implementing them. There is a noteable accent on solid waste management as this is the dominant and urgent issue today, be it for a small or large municipality.

The conference is initiated by the Cost Effective Technologies Environment Committee for Northern Ontario (CETEC-North) whose aim is to encourage and sponsor innovative technologies for Northern Ontario that are both environmentally sound and cost-effective. The Committee realizes that this small volume is just a tiny step forward on the path of environmental sustainability. It needs, of course, to be multiplied a thousand times, but if it only points the way to our third Technology Transfer Conference, then it will be all worthwhile.

Philip Joseph,
Chair,
Conference Steering Committee.

WASTE AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

From Theory to Practice:
Sustainable development and Waste Management

Peter Higgins
Environment Canada
September 1990

Sustainable development (the popular shortening of environmentally sustainable economic development, a concept developed in great detail by the Brundtland Commission) is now in common usage, and is often used in connection with global environmental problems of almost overwhelming magnitude: global warming, species extinction, deforestation. These and similar problems can be perceived as so immense as to be almost beyond effective action by ordinary people. Thus, despite many efforts that are under way, there is some danger of sustainable development being viewed as a fad, or an irrelevant abstraction.

Various innovative Canadian waste management initiatives address sustainable development issues in a concrete and practical way that makes the concept meaningful in everyday life. The National Packaging Protocol will reduce packaging waste in Canada by 50 percent by the year 2000. The implications of this for sustainable development are significant.

Likewise, Canada's National Contaminated Sites Remediation Program not only addresses a difficult environmental problem which threatens the security of various resources, but can also serve as a model for how to go about tackling seemingly unsolvable problems.

These two initiatives, and other complementary Canadian initiatives such as the Environmental Choice Program and the Environmental Partners Fund, demonstrate that sustainable development is an attainable goal, as opposed to an abstract ideal. Their methodological lessons can be applied elsewhere.

From Theory to Practice:
Sustainable Development and Waste Management

Peter Higgins
Environment Canada
September 1990

Ever since the Report of the World Commission on Environment and Development--the Brundtland Report--was issued, the term sustainable development has come into common usage. Sustainable development is actually popular shorthand for a more complex concept originally described by the Brundtland Commission as environmentally sustainable economic development, which sought to balance the need for poverty alleviation and requirements for economic development with the absolute necessity of preserving a sustainable environmental future on this planet.

Frequently, people think of sustainable development as a response to some of the problems linking environment and development which have become so familiar in recent years:

--Some 15 million acres of productive land around the world are converted into worthless desert every year. In Canada alone, we lose 26 acres of productive farmland every hour to urbanization.

--Some more than 27 million acres of forest are destroyed throughout the world every year.

--Global warming, ozone depletion and other worldwide air quality issues have been recognized as genuine threats.

--Deforestation caused by logging, farming, ranching and mining might cause the extinction of up to one million species by the end of the century.

The idea that the economy and the environment are inseparably linked, and that we on this planet have reached the point where continued heedless environmental abuse will have a negative effect both on economic prosperity and on the ability of ecosystems to sustain life, has finally begun to penetrate.

Sustainable development is seen as a response to this crisis. Business people and environmentalists, planners, managers and politicians at every level; all have made frequent references to sustainable development during the past few years. This is an extremely positive sign. It indicates that humans are finally starting to bestir themselves to do something about the tremendous environmental mess they've made.

But sustainable development seems to be a rather amorphous concept. Everyone talks about it, everyone is in favor of it, but very few people can define it in practical terms. The Canadian Council of Ministers of the Environment (or CCME, a council made up of the federal, provincial and territorial environment ministers) has come

up with a useful and succinct definition of sustainable development, which closely follows the Brundtland Commission. The CCME definition is:

> Development which ensures that the utilization of resources and the environment today does not damage prospects for their use by future generations.

Nevertheless, it might be argued that there are two dangers inherent in the way that sustainable development is perceived by the general public. The first is that, given the media's short attention span, sustainable development might fade from public consciousness before it can gather very much momentum.

The second is that sustainable development may be seen too much as an abstract principle, or be seen as a global issue that can be addressed only at the highest levels of policy and action. In other words, it might be equated with problems which are serious, but whose causes are perceived as being beyond peoples' control, as they lead their daily lives.

Of course, sustainable development must address issues such as ozone depletion and the loss of tropical rain forests. But it is absolutely crucial that sustainable development be seen as more than an intimidating grand ideal, applicable only at the highest levels. Noble as it is as a concept, sustainable development will

be a failure if we cannot make it very concrete, and implement it in very practical ways. Never has the phrase, "think globally, act locally", been more appropriate. For sustainable development to work, people as individuals have to become involved, through their lifestyles and the everyday choices that they make.

For example, waste management might seem like a very mundane issue. Certainly it is not very glamorous, not when compared with ozone depletion or species extinction or saving the whales.
Every city, town and hamlet in Canada has been dealing with waste, for better or worse, since day one.

But this is precisely the point. Canadians were familiar with waste management to the point of boredom. Then, they discovered that they had a waste management crisis on their hands, one that was threatening the sustainability of a variety of resources.

Waste management is an urgent and pressing problem in Canada. Each year Canadians generate 30 to 35 million tons of waste, of which about 16 million tons is from household and commercial sources. For the year 1989, on a per capita basis, Canada produced more waste than any other country in the world: 1.7 kilograms per person per year. Overall, Canadians spend over $1.5 billion per year on waste management.

And now, the effects of these practices are haunting us. Our large cities are running out of landfill space. The costs of waste disposal have skyrocketed, and city managers are faced with the unhappy choice of raising taxes or cutting other programs. Improperly disposed of wastes are threatening water tables. Shortages are beginning to be felt of resources which were once used lavishly, without a thought for tomorrow.
So the very commonplace issue of waste management is interlocked with sustainable development in a variety of ways. Scarce resources are used in inefficient ways. Habits of consumption are wasteful. Inefficient disposal practices jeopardize other resources. All of these things are threats to sustainable development.

For these reasons, anything that is done to improve waste management practices--reduction, reuse, recycling and recovery, better disposal--helps advance the principles of sustainable development. Above all, if waste can be reduced at its source, that is, not produced in the first place, many problems can be avoided further on. It's the old story, an ounce of prevention is worth a pound of cure. And, if waste is produced, it should be regarded as a resource that can be mined, just as minerals are taken from the ground.

This type of approach to sustainable development is also something that people can understand, in their daily lives. The rain forest

and the ozone layer might be a bit removed from everyday experience, but everyone understands garbage.

Canada is addressing the issue of waste management in a variety of ways that make a very real, practical contribution to sustainable development. One of the most interesting and innovative of these initiatives is the National Packaging Protocol.

The contribution that packaging makes to Canada's waste management problems is substantial. The per capita consumption of packaging in Canada stands at an estimated one ton of packaging per family per year. In total, packaging in Canada consumed 6.6 million tons of material in 1988, most of which was disposed of at great environmental and economic price. Roughly 80 percent of Canadian packaging is ultimately handled by disposal, rather than by recycling or reuse. Some 5.7 million tons of packaging material is landfilled or incinerated annually, at an estimated cost in excess of $100 million. These practices simply cannot be considered as sustainable.

To come to grips with this problem, the Canadian Council of Ministers of the Environment has developed the National Packaging Protocol. This is a plan of action, composed of six packaging policies for Canada, that will reduce the burden of packaging by 50 percent from 1988 levels, between the present and the year 2000.

The Protocol is achievable, and it contains firm targets, so that progress can be measured as the policies are implemented. An interim 1992 target of a 20 percent reduction from 1988 levels will reduce annual waste collection and disposal costs by $50 million. Further targets are a reduction of a 35 percent by 1996 and a 50 percent reduction by the year 2000. These will bring total savings from the program to almost $1 billion. Here are the six policies of the Protocol:

1. All packaging shall have minimum effects on the environment.

2. Priority will be given to the management of packaging through source reduction, reuse and recycling.

3. A continuing campaign of information and education will be undertaken to make all Canadians aware of the function and environmental effects of packaging.

4. These policies will apply to all packaging use in Canada, including imports.

5. Regulations will be implemented as necessary to achieve compliance with these policies.

6. All government policies and practices affecting packaging will be consistent with these national policies.

The Protocol is being implemented by a broad range of actions that address the many facets of packaging issues. A Code of Preferred Canadian Packaging Practices is being developed with government and industry participation; this Code will guide the design of products and the selection and design of packaging. Standards will be established for packaging that will take into account health, safety, performance, and consumer and regional requirements. Industry and government's will work together to develop infrastructures that will foster the recycling and reuse of packaging materials, and to develop markets for recycled packaging materials.

The Protocol is a voluntary and cooperative effort; thus, industry is free to choose the most effective means to meet the Protocol's targets. However, the initiative is a serious one, and should the voluntary approach not work, or prove to be too slow, the CCME ministers are preparing a regulatory package that could be implemented if necessary.

A Canada-wide data collection and monitoring network is being set up and will be in place by December 1, 1990; the setup of this network is the first of the Protocol's milestone targets. Long and short term communications and information plans are being developed

by the parties to the Protocol, and a uniform national reduction, recycling and reuse infrastructure will be put in place across Canada.

Sustainable development means tackling the causes rather than the symptoms; it means anticipating and preventing problems. The Packaging Protocol is designed to stop packaging waste at its source, and it will also help change peoples' perceptions, and the way they make choices every day that can effect the environment.

The Protocol is an effective means of addressing the contribution that packaging makes to waste management problems in Canada. Other aspects of waste management are being tackled in equally concrete ways. Take another extremely vexing problem: that of sites contaminated by toxic substances. A lack of knowledge and of proper controls has led to the existence of hundreds, perhaps thousands, of contaminated sites across Canada.

The problem is vast. Based on provincial and federal inventories, over 10,000 landfills dot Canada's landscape. To varying degrees all of these contain some toxic waste--whether from commercial or industrial facilities or simply from household goods; such things as automobile batteries, unused pesticides and cleaning compounds. There are also problems with leaking underground storage tanks, used for such things as chemical products and gasoline. There are some 200,000 such tanks in Canada; it is estimated that between 5

and 10 percent of them are currently leaking, and that a further 28,000 will start leaking within the next five years.

The approach used for this issue is similar to that which produced the Packaging Protocol. A vast and complex problem is being analyzed and broken down, so that practical and concrete steps to address it can be devised. In particular, Canada faces four specific challenges in addressing the contaminated sites issue.

First, perhaps the greatest of these challenges is the lack of knowledge that hinders remediation efforts on a number of fronts. Canada's knowledge base is incomplete, with regard to both the location and the characteristics of contaminated sites in Canada. Second, our ability to assess or predict accurately the degree to which such sites are impacting on human health or environmental quality is limited. Third, the effective remediation of contaminated soil, sediments and groundwater is technically very complex. Methods, to a great extent, have yet to be proven in the field. Fourth, the costs of identifying, assessing and cleaning up contaminated sites in Canada will undoubtedly be extensive.

Again, in the future, the real answer is prevention. Far better to avoid creating a toxic waste site in the first place than to have to clean it up after the fact.

The challenge of cleaning up contaminated sites is a very great one. Up until now, governments and industry in Canada have been addressing the contaminated sites issue in a variety of ways and on a number of fronts. In recognition of the potential magnitude of the problem and the lack of a consistent national approach to deal with it, the issue was placed on the agenda of the CCME ministers. In October, 1989, the federal, provincial and territorial governments announced a National Contaminated Sites Remediation Program.

Remediation of contaminated sites throughout Canada will be based on the "polluter pays" principle. The CCME ministers agreed to establish a $250 million, five year cost shared program to remediate "orphan" sites, and to stimulate the development and demonstration of innovative remediation technologies. The program will be implemented according to four principles:

1. Jurisdictions will have the necessary laws, regulations and programs in place to ensure the remediation of all high risk contaminated land sites where the responsible party can be held accountable consistent with the "polluter pays" principle.

2. Common assessment and remediation criteria and/or guidelines will be used to deal with contaminated sites.

3. Governments will clean up those sites where they are the responsible polluters.

4. Each of the provinces and territories will have access to a portion of the program based on a per capita formula.

Government funding of the program began in April of this year, the first joint technology demonstration project under the Program has been announced for downtown Vancouver at the contaminated "Pacific Place" site, and a number of negotiations are under way to identify orphan site cleanup opportunities.

The Packaging Protocol and the Contaminated Sites Program are examples of programs where the federal and provincial governments are working together to help make sustainable development a reality in our society.

The federal government's approach to waste management in general, and hazardous waste management in particular, is an integrated one, and is based upon the four Rs that I mentioned earlier: reduction, reuse, recycling and recovery. Last December, a Waste Management branch was created within Environment Canada to coordinate the growing involvement of the federal government in waste management activities.

The mandate of the Hazardous Waste Management division can be summarized in four basic points:

1. To ensure that generation at source is reduced to a minimum;

2. To dispose, as much as possible, of Canadian hazardous wastes within Canada;

3. To establish an enhanced system for hazardous waste exports and imports; and,

4. To cooperate in the exchange of information, technology transfer and harmonization of standards, guidelines and codes.

Internationally, Canada is working with organizations such as the United Nations Environmental Program (UNEP) and the Organization for Economic Cooperation and Development (OECD), to ensure that nations are responsible, within the global context, for the hazardous wastes which they generate. To this end, Canada has signed, and was very active in the development of, the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal.

The federal government has also been working on a comprehensive program to deal with hazardous wastes and toxic substances in areas

under its exclusive jurisdiction. It uses a number of pieces of legislation to cover the various aspects of hazardous waste control; the most important are the Transportation of Dangerous Goods Act and the Canadian Environmental Protection Act. Environment Canada has a number of authorized inspectors under the TDGA and CEPA who perform random inspections of hazardous wastes.

The Transportation of Dangerous Goods Act has been updated and strengthened. A cradle to grave tracking system has been put in place for toxic substances. Disaster response and emergency preparedness measures have been upgraded and tested.

Regulations and guidelines have been put in place regarding all aspects of hazardous waste management that are under federal jurisdiction. These initiatives reduce the risk of contamination and, if an accident does occur, they help to pinpoint its location and ensure a fast and correct response.

As effective as these measures are, however, they alone are not enough to cope with the full scope of Canada's waste management challenges. As the National Packaging Protocol and the National Contaminated Sites Remediation Program demonstrate, Canada is now beginning to forge the partnerships necessary to address the totality of the waste management issue.

Canada is taking the concrete, practical and achievable measures necessary to solve one particular environmental problem. It is not glamorous, but if Canada, and the other nations of the world, can find the will and the resources to take equally methodical and effective approaches to the other problems of environment and development that confront us, the ideal of sustainable development will become more of an attainable goal, and less of an abstract ideal.

FUTURE OF MUNICIPALITIES FROM A BUSINESS PERSPECTIVE: REHABILITATION OF MUNICIPAL INFRASTRUCTURE

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A BUSINESS PERSPECTIVE ON THE MANAGEMENT OF MUNICIPAL INFRASTRUCTURE

ABSTRACT

Northern Ontario municipalities have unique problems in dealing with rapid technological change and environmental agendas driven by the problems of more densely populated areas. Many existing sewer and water systems are substandard, which results in unnecessary demands on water supply and sewage treatment facilities, and adversely affects treatment processes. Such conditions may jeopardize opportunities for economic growth. New tools exist to permit municipalities to maintain current accurate records of the condition of existing inventories of sewer and water systems. Province-wide standards for infrastructure data base systems have been developed (SIMS, WIMS, RIMS) by the Ontario Municipal Engineers Association, the Ontario Good Roads Association and the Ontario Section of the American Public Works Association. Other software has been developed to facilitate bulk entry of data into these systems, and to provide graphics capability for various output formats. Once the data base is established, municipal utilities will be easily able to maintain these systems in-house and to generate accurate current status reports of infrastructure needs and priorities. Proper use of these systems will ensure that utilities protect the significant investment represented by our existing utility systems through timely and cost efficient inspections, maintenance and replacement programs. These systems, if kept current, will also permit prompt and effective response to Federal and Provincial grant programs. Financial strategies to deal with infrastructure needs are essential, as is the need to pass extraordinary system costs on to the generators of these costs.

A BUSINESS PERSPECTIVE ON THE MANAGEMENT OF MUNICIPAL INFRASTRUCTURE

Municipal utilities represent some of the largest business operations in Northern Ontario. Their success in planning, developing and maintaining municipal utility systems is critical to maintaining a climate attractive to new development and affordable to its citizens.

As with any business, municipalities must devote some resources to protect their existing investments, and to progressively repair or replace deficient components. At the same time, they must organize and dedicate other resources to invest in their future. This may include investment to always be in position to respond to new development opportunities. Other resources must be devoted to the identification of future trends or technological changes to minimize their impact on existing infrastructure and the financial stability of the utility.

FUTURE TRENDS

We are in a period of history in which human knowledge is expanding at an incredible rate. With this increased knowledge, we are able to identify social, economic, health and environmental concerns much faster than we can address them.

Northern Ontario municipalities face a special challenge. Unlike the Golden Horseshoe, our tax base is not growing. Our industries are threatened by many factors and in many cases are declining. Our population is aging. Perhaps most importantly, our agendas are created by Southern Ontario problems and priorities. Our few opportunities for major economic growth seem doomed to frustration

or failure by today's public values. While these values have, by and large, been created by and are related to the problems prevalent in more densely populated areas, they are also firmly supported by many Northern residents.

Concern over our environment is universal. Zero discharge of toxins, 100% recycling of waste, and zero impact on the natural environment and human health are popular goals which will demand an ever-increasing share of our resources. Government efforts towards much more stringent controls and enforcement have wide public support. While many of these controls will affect private industry, municipal responsibilities are also increasing rapidly. More and more we are seeing the Federal and Provincial Governments restricting their roles to the establishment of standards and the punishment of violators. The costly role of monitoring, inspection and compliance is being passed on to the private sector and to municipalities.

EXISTING MUNICIPAL INFRASTRUCTURE

Much of Northern Ontario's municipal infrastructure was developed at a time when construction capabilities were quite limited. This, combined with the challenge of rocky terrain, often interrupted only by zones of weak soils or muskeg, lead to the installation of many systems woefully substandard by today's measure. Shallow systems subject to frequent breakage due to frost heave and requiring bleeding in the winter to prevent freezing are quite common in many northern municipalities.

These substandard systems, by their very nature, have resulted in substantially higher demands on water supply and sewage treatment facilities. Residential per capita flows up to four times Southern Ontario standards are not uncommon. Upgrading these substandard systems would substantially reduce the demands on many municipal water supply and sewage treatment plants.

Significant flow reductions would obviously reduce plant operating costs. In many cases, the elimination of extraneous flows would also substantially improve the efficiency of treatment processes and eliminate the need for major plant expansions due to hydraulic overload conditions.

This is particularly significant in Northern Ontario, which has many water and sewage treatment plants which do not meet today's desirable standards. Undesirable levels of colour, turbidity, iron and chlorinated organics are common in many municipal water supplies. Frequent overflow and bypass conditions, inadequate nutrient removal and inconsistent treatment results are not uncommon in many of the region's sewage treatment plants.

STRATEGIES TOWARD REHABILITATION

Recent surveys by a variety of agencies have generated wide ranging estimates of the extent of the rehabilitation needed for our crumbling or substandard municipal systems. It is evident, however, that few municipalities today have an accurate picture of the present condition of their buried pipelines. Fewer have dedicated reserves or any financial strategies in place to deal with this major problem area.

The present process seems largely based on the philosophy "if it works, don't fix it". This results in a reactive process responding to breakages, stoppages or spills, as they occur, aften at great expense due to overtime charges, property damage and the inefficiencies of frequent unplanned spot repairs.

INVENTORY

All municipalities should maintain current, accurate and complete records of their various utility systems. Aside from their physical condition, characteristics

and age, such records should include repair histories, periodic checks for leakage in watermains and measurements of infiltration in sewer systems.

A variety of methods have been used to analyze the condition of existing utility systems. These include TV inspection, manhole inspections, house inspection, smoke and dye testing, leak and corrosion surveys, flow measurement and maintenance records analysis. More recently, the development of p.c. programs has made the compilation and retrieval of systems data more practical, affordable and accessible to Ontario municipalities. Initiated in 1985 by a tri-partite committee of the Ontario Municipal Engineers Association, the Ontario Public Works Association and the Ontario Good Roads Association, computer based software has been developed which is intended to serve as a standard for all Ontario municipalities. The Ontario Ministry of the Environment and the Ontario Ministry of Transportation have endorsed this software and are providing grants to assist municipalities to implement these systems. A series of entry level software packages known as SIMS, WIMS and RIMS has been produced to manage inventory data for sewers and watermains and roads.

To date, more than 20 municipalities are using SIMS and RIMS. These programs list in standard format all pertinent information related to existing piping and appurtenances including full maintenance histories. Once established, this data base enables municipalities to maintain permanent records of critical information in one source, which previously were scattered in many locations, some of which were only in the memories of operating personnel. The same software is capable of generating work orders and assisting in budgeting and forecasting operations.

The task to prepare this initial data base is formidable; however, innovative approaches can substantially reduce the cost to digitize information which is presently available in graphic form. At Proctor & Redfern, we have developed a number of programs to quickly digitize system geometry and to bulk load much data into SIMS and RIMS. Costs to start up SIMS and RIMS in a municipality today vary considerably but are in the order of $150 per serviced lot. More than half of this cost is related to actual physical inspections (TV inspections, manhole inspections, leakage, infiltration and smoke testing).

The initial start-up of SIMS and RIMS is usually assigned to a consulting engineer; however, municipal personnel should participate actively in the process and be trained to be able to continue future maintenance of the data base in-house.

The SIMS and RIMS software has no graphic capability, which limits its usefulness. At Proctor & Redfern, we have developed sophisticated computer programs which link SIMS and WIMS to graphic displays. This software can be used by utility personnel to determine such information as the exact location of system components, the date when a sewer was last checked and/or serviced, and the next date for servicing. The system can also indicate priorities and sequencing of events so that several different operations can be accomplished at the same time. For example, if a replacement or repair of a sewer necessitates digging up a section of roadway, the system will indicate other maintenance activities needed on the same street for other utilities.

NEEDS STUDY

The completion of the data base inventory enables a municipality to easily develop a Needs Study for its utility networks. Such a study should identify both repair

and replacement needs and other works necessary for growth or to meet new requirements. Upon completion, the identified needs can be prioritized. The resulting summary becomes a valuable tool in establishing annual budgets. Moreover, such documentation permits a municipality to respond quickly to funding opportunities which arise from time to time through Federal and Provincial Government initiatives.

FINANCIAL STRATEGIES

Municipal budgets are under severe strains today. This is partly due to significant transfers of fiscal and other responsibilities from senior governments, but is also due to rapid advances in technology. This trend is likely to continue as the MISA program and other programs continue to expand. It is, therefore, even more essential that adequate resources, including adequate reserve funds, are provided for such bread and butter items as the basic fabric of our municipal infrastructure systems. Utility rate structures must provide resources for system maintenance and rehabilitation. Rate structures should reasonably extract payment from customers in direct relationship to their demands on the utility. Generators of troublesome or excessive waste should pay premium surcharges to recover extraordinary costs experienced by public utilities. This will encourage system users to become part of the conserver society to everyone's mutual benefit. Special attention must be paid to government initiatives to maximize potential grant support of municipal utility systems. Such present government initiatives as special funding under the Blue Box and Lifelines programs amount to incentives to encourage municipalities to participate in specific activities. Typically, such special funding is terminated over a relatively short period. Municipalities who fail to take advantage of the special offer often find they are subsequently compelled to introduce these programs at a later date, but entirely at their own cost.

SUMMARY

Our society is clearly in the environmental age and we can reasonably expect continuing forceful government policies directed to the clean up of our environment. Much of the burden of responding to these publicly endorsed efforts will be left to municipalities and their public utilities. In such an environment, it is vital that municipalities take stock of their existing infrastructure, organize their preventive maintenance and rehabilitation programs to be cost effective, and to constantly maintain an accurate and prioritized inventory of their infrastructure needs. It is equally essential that adequate financial resources be established and maintained to prevent deterioration of our valuable utility systems, and to avoid massive barriers to future development or catastrophic financial demands on our limited municipal financial resources.

COST EFFECTIVE TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT IN NORTHERN ONTARIO

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REMARKS ON THE CONCEPT OF SUSTAINABLE DEVELOPMENT

MADE TO THE

INNOVATIVE TECHNOLOGY

TRANSFER CONFERENCE

FOR

NORTHERN ONTARIO

SAULT STE. MARIE, ONTARIO

OCTOBER 16, 1990

BY

PHILIP JOSEPH, P.ENG.

INTRODUCTION

On your program there are a number of presentations from specific technologies for sustainable development and I am therefore broadening my remarks more than the program title suggests. I shall therefore attempt to examine the concepts of sustainable development in terms of what it has been in the past and what it is today. We shall have a peek into the future to try and see whether the concept serves the fundamental needs of our planet. Our terms will look at the real world of resources, biology, and human endeavour as shown on this overhead [Overhead 1].

If we are to achieve this objective, our scope must be wide and of course, we shall not be able to dwell on any one parameter for any great time. We shall look at our basic resources arising from the land, water and air that we live on. Intrinsic to all 3 is energy use. We shall examine the preservation of species that abound on this earth. And we shall have a little to say about how we manage ourselves, our habits, customs, economics, politics, what we want for ourselves and, dare I say, for our global neighbours.

THE PAST

Our first section takes us back to the golden age that never was. I have often heard it expressed that our parents never had the pollution problems we now experience. Or on a different timescale there were no environmental brakes on the industrial revolution. And even before that, that the ancient Greeks lived in the

golden dawn of civilization. Not so. It was just that those previous societies were borrowing capital from the future or they did not have the technology to understand the effects of what they were doing. Our ancestors, or at least most of them, were no less rapacious than we are - just less powerful.

For example, records show that previous civilizations depleted the resources around them as blindly as we do today. Their circle of operation was much smaller than today, however, and did not encompass the globe. Let's look at Easter Island, lying some 2,000 miles west of Chile and home of hundreds of giant stone statues, some erected in grassy plains, some fallen over, and some unfinished in the quarries. This isolated island was "discovered" in 1722 and the mystery of how the huge statues were transported scores of miles from the quarries and erected remained until recently. Archaeological and paleontological studies have detailed Easter Island's history. When Polynesians settled the island around AD400, it was covered by forest. Trees were cut down for gardens and to obtain logs for canoes. Some logs were used as rollers to move the 40 ft long statues and to help erect them as levers. But the deforestation led to erosion and lower field crops. Also, there were no logs left to build canoes for fishing. The island society collapsed into internecine warfare and cannibalism leaving a lonely grassland littered with fallen statues in place of a lush island and a remarkable civilization. The rise and fall of Easter Island took place in little over a thousand years.

There is another similar example of resource depletion on this continent. When Spanish explorers arrived in the southwest in the 16th century they found strange evidence of an advanced civilization rising from the desert. There were immense 5 storey structures, 650 ft long, 300 ft wide with 600 rooms. It was as if the Navajo Hilton had been erected and abandoned in the middle of a barren desert in New Mexico.

Archaeologists subsequently discovered that construction of the Chaco pueblos began just after AD900 and ceased about the 12 century; why was the city erected in a barren wasteland? Where were the 200,000 16 ft logs obtained from to build the roofs? Investigation of the local vegetation by radiocarbon dating showed that at the time of construction the Chaco pueblos were not in the middle of a desert but in the middle of Juniper woodlands and Ponderosa pine forests. After the local areas were cleared the Anazani Indians had to go up to 50 miles to obtain wood for both burning and building. Irrigation channels were built but as deforestation caused increasing erosion and run-off the gully's deepened below the water table resulting in drought to the Anazani fields and ecological disaster. All in the space of 250 years.

And, of course, resource depletion was accelerated enormously by the industrial revolution. For example, the forests of England were devastated in the course of about 50 years to supply charcoal and the increasing appetite for wood to fuel the iron foundries.

Turning to the protection of species, we cannot say that our forebears had any more sensitivity to protecting the species than we do. When British colonists settled in New

Zealand in the 1800's, their ploughs discovered the bones of large birds that were already extinct and which the Maori remembered as Moa. We have a good idea from complete skeletons and egg shells what these birds looked like. They were ostrich-like, flightless and about 10 ft tall. Fossils showed that the ancestors of the Moa had come to New Zealand millions of years ago. Why did the birds become extinct? Up to recently it was believed that the species died out because of climatic changes. This theory has been demolished in 3 ways. Radiocarbon dating proves that when New Zealand was populated by Polynesian migration - i.e. the Maori - around 1,000 AD, most if not all, the Moa species were still in existence. So were dozens of other species including large geese, ducks, swans and eagles. Why were all of these species wiped out in the course of 500 years after human settlers first arrived? It would be an incredible coincidence if dozens of species that had thrived for millions of years suddenly become extinct through natural causes in a blink of geologic time. Secondly, more than a hundred Maori archaeological sites are known where there is evidence of the remains of large numbers of Moa, much more that could have existed at any one time. It appears that the Maori had been eating the birds, using their skins for clothing and their eggs for water carriers for many generations. Thirdly, radiocarbon dating shows a fascinating pattern of migration. The oldest sites date from AD1150 in the north. As one moves southward, the sites become progressively younger to the youngest in the far south at about AD1450. The Maori must have gradually spread southward hunting Moa's to their extinction as they advanced.

On this continent about 11,000 years ago when the first ancestors of the American Indians filtered through the Bering Straits, most large mammal species become extinct

at about the same time. Giant armodillos, saber-tooth tigers and mammoths appear to have been hunted out of existence as the migration proceeded southward.

In Madagascar off the east coast of Africa, the first human settlers were Indonesians and Africans who arrived around AD500. On the island were giant tortoises, aardvarks, pigmy hippos and flightless elephant birds weighing up to 1,000 lbs with egg shells holding over 2 gallons. But by the time French colonists arrived in 1643 all these species had been wiped out. The probable causes for extinction were hunting, deforestation, erosion and cattle grazing - causes which sound familiar to us today.

And to cap off these examples of species extinction we need only to refer to the slaughtering of the buffalo on the North American plains at the end of the last century. The buffalo herds estimated at 75,000,000 were reduced to a few hundred survivors in the course of a few decades. This sets the stage for the disastrous dustbowl conditions in this century.

And what of human treatment of each other in the past? Were societies modelled on equitability, fairness, justice, non-belligerancy? I hardly need tell you that they were not. Sustainability was not even a question. When Homo Sapiens first organized into primitive tribes, all were equal and had to participate in the hunt because the productive capacity was such that at best one could feed and clothe one self and no more. But the tribes fought each other over hunting grounds mercilessly. As man later learnt to grow food instead of hunting it, productivity increased. One's output not only supported that person but others as well. It was now profitable to

employ slaves to do the hard work while others ruled. The great civilizations of the middle east, the Sumerians, Egyptians, ancient Greeks, were not remotely sustainable if you took away the slaves. The feudal societies of a thousand years ago waged war amongst themselves with relentless fury limited only by geography and the power of their weapons. The industrial revolution broke the feudal bonds and international commerce soon reached into every corner of the world. We are most familiar with this side of human endeavour but I doubt whether any of you believe this is founded on fairness or equitability. Industrialists have not asked whether it is right or proper to do such a thing. Only whether they have the ability to do it and can make a profit out of doing it.

THE PRESENT

Now I have spent this time on the past in the hope to have drawn some lessons that will benefit us today when considering sustainable development. Firstly, it does appear that depletion of the earth's resources has always been going on but at an accelerating rate. Secondly, it is likely that succeeding societies have exterminated species that they are in contact with. And thirdly, man's ascent from primitiveness has been dominated by concerns about his immediate well being. We must now examine whether we can go on this way.

Let us look briefly at the present state of the environment [Overhead 2].

- In Brazil alone, the rainforest the size of Belgium is disappearing each year. At the rate we are going there won't be any rainforest left within 50 years.

- Species are disappearing hundreds of times faster than nature's cycle (1,200 every 400 days compared to 1 every 400) before we can even catalogue them.

- Coral reefs are destroyed in the Phillipines by blasting and cyanide poisoning - a classic case of the poor destroying their own future to increase the fish catch.

- Wetlands are rapidly diminishing in Canada as urbanization spreads.

- Desertification - US space photos show that Lake Chad, which is bigger than Lake Ontario, has almost dried up in the course of 15 years; and Canada is not immune from loss of topsoil. Our loss is about 5% per year.

- Ozone layer depletion not only increases skin cancer, it results in almost exactly parallel depletion in crops, such as wheat or soya beans. This year the ozone layer over Toronto is 7% thinner than the past 25 year average.

- Greenhouse gases - an increasing build-up of carbon dioxide, methane, chloroflorocarbons, nitrogen-oxides.

- Ocean pollution - red tides which are basically toxic algae growth, killed 3,000 dolphins recently off the US coast.

- Acid rain has already killed life in 14,000 east Canadian lakes and has damaged one-fifth of Europe's

forests.

- Chernobyl radiation leak, Exxon Valdez, Hagersville, - need we go on. Crisis management is bad economics. Chernobyl has cost $5 billion so far, Exxon Valdez $3 billion and even our local tire fire at Hamilton will cost $35 million for clean-up and there's not that much money in old tires.

I have drawn your attention to these examples only to show that we cannot do things in the same way. Our ancestors have used up some of the earth's capital in the past, and we are now doing so at such an accelerating rate that by the middle of the next century we will have very little left. What then are we doing or should we be doing at this time in the 90's? Let's look at the four main areas of activity which have to co-operate in order to make sustainable development really work - the government, laboratories, the boardroom and the home.

First, the government, and I include the three levels of federal, provincial and municipal. Modern society is based on laws written down by governments and the general acceptance of law by a great majority of people. Our daily actions, although they may seem voluntary all have as bottom line the compulsion that if you don't do things in a certain way you are going to get punished. So, if we don't have a law that says when you develop something you must take care of long-term environmental considerations, then those considerations are in the main neglected. And even when considerations are made but not enforced, such as in the application of the Environmental Assessment Act, then this amounts to the same thing. We do not have laws

on sustainable development. Governments have to enact laws to define sustainable development in terms of sectoral activities, of their specific impacts on the local and global ecologies, and of their immediate and long-term implications. Needless to say, those laws have to have teeth in them and sufficient staff to clamp down on disregarders.

There are some international agreements useful as a beginning to this process. I can mention the Montreal conference of 1988 that laid down limits of CFC emissions or the European agreements on acid rain or even Ontario's own emerging regulations on MISA - Municipal and Industrial Strategy for Abatement - but these are at best piecemeal and at worst non-enforceable measures. They treat the symptoms and not the disease.

Now the production of such laws requires an enormous account of expertise and research. This brings us to the laboratories and the involvement of scientists, biologists, engineers, sociologists and a host of other academic disciplines. Let us look at this overhead for a moment [Overhead 3]. I think this equation or relationship that says sustainability is equal to the available resources divided by life dependent on those resources, is fundamental. If resources are depleted, sustainability goes down. Similarly, if dependent life increases, particularly human life, then sustainability also goes down. So if we are not just playing with words but are serious about sustainability here is the big question. How much resources are required to sustain into the future the life dependent on those resources? The question can be raised in the local, regional or global sense depending on the activity proposed. For example, we

now know that peaceful uses of atomic energy involve grave risks on a global scale to the life and health not only of humans but to vast areas of agricultural land, animals and millions of species. Can we accept those risks? Surely we have to inventory all the resources that are likely to be affected, research life processes and find out how much, if any, radioactive contamination the dependent life can absorb before coming to an answer. On a local scale, if a subdivision uses up valuable land, is there a real need to replace that agricultural protein and if so, can it done with opening up new farming lands or raising productivity? As you can easily see the answer to these questions is an enormous task for researchers and we have barely started on it.

Let us turn our attention to the boardrooms now, to the industrialists, the constructors, the leaders of commerce. Is the greening of the boardroom real? Our answer is a qualified yes even if the colour is pale and thinly spread. Our first example is Inco of Sudbury, practically on our doorstep. As little as over 5 years ago, Inco was resisting every attempt to tighten up on its sulphur dioxide emissions - the main contributor to acid rain - but last year it inserted ads in major newspapers announcing it was investing "$500 million in something we'd all like to see: clean air". The copy also proclaimed that "From our perspective, it's time to stop talking and take action". Inco's Roy Aitken says and I quote "There's no question that we had a free ride on the environment. Now we've got to spend money to make sure its restored." My oh my! Similarly Adam Zimmerman, boss of Noranda Forest, a major player in the pulp and paper industry, is on side. From another industry, Dowe Canada's Dave Buzzelli has authorized scores of millions

of dollars on environmental programs. He champions a policy called "Responsible Care" which is a cradle-to-grave stewardship program for chemicals. Possibly, the most advanced industries at integrating environmental considerations into their business operations is oil and gas. The Canadian Petroleum Association has developed extensive codes of practice for its members on this subject and has spent hundreds of millions of dollars on research and improving its industrial processes. Loblaws' chief marketing whiz, Dave Nichol has spearheaded a drive to introduce more than a hundred "Green" products in company stores across the country.

Now I don't think for a moment that these boardrooms, important and welcome as they are, have been persuaded to adopt a green line by lectures from environmentalists. Their persuasion has been and will always be the bottom line for their companies. How best can they secure their own profits? And this is a consideration we must understand and work with to obtain their continuous involvement and co-operation.

It is evident that in the 90's these corporations have come to realize that the protection of their profits comes fundamentally from public attitudes to their activities. An aroused public, aware of environmental degradation and resource depletion, can boycott the products of companies and force governments to enact green laws and regulations. Moreover, key sections of the labour force are becoming progressively more articulate in demanding that their companies preserve a green environment. It is no accident that Ontario's countdown acid rain program, ordering Inco, Falconbridge, Algoma Steel and Ontario Hydro to cut SO2 emissions 50% by 1994 or the MISA program for the

petroleum industry caused a change of heart in those boardrooms. The business community is fearful of more regulations and if they see it coming will pre-empt it. Quoting Roy Aitken again, he says "If you sit on the sidelines you'll eventually end up with the regulations you deserve. And those, typically, will be punitive with mult-million dollar fines and jail terms.".

Let us turn our attention now to the home. What part can we and our families directly play in advancing the concepts of sustainable development?

Garbage and recycling is an upfront priority. If your municipality hasn't got a blue box program make sure it starts one. Tie up newspapers in separate bundles from glossy magazines. One newspaper recycled for a year saves 2½ trees, half the energy and half the water than when paper is made from virgin wood pulp. Rinse cans and bottles before putting them in the blue box. Save your plastic separately. If you do not have recycling depots yet for plastic you soon will have. Obtain a composting box or make a heap in the garden. Deposit all your organic wastes and mix equally with leaf or other carbon wastes. In a year you will make a fine humus to benefit your garden. For those with babies some hard advice - forget about disposable diapers: they account for 3% of solid waste. Use cloth diapers and wash them at home or use a clothe diaper service. And at your store, reduce your packaging waste by buying in bulk wherever possible and refusing products that are overpackaged with glossy sell material. And a few words on hazardous wastes. If your municipality does not yet have a program for collecting or disposal of hazardous wastes, insist that they start one. Paints, oils, solvents, toxics, batteries

are significant sources of pollution when sent to a landfill site and should be separated at source.

Energy efficiency in the home can be a useful brake to spiralling demands for more electric power. As Canada has the dubious distinction of having the highest per capita consumption of energy in the world, there is plenty of room for improvement (the 1986 figures from the World Bank show that each Canadian uses the equivalent of 8,945 Kg of oil per year, while the average industrial economy uses 4,952 Kg and the developing countries a meagre 506 Kg per person per year). Appliances use about a quarter of the total energy used in home. When buying a new refrigerator, stove, washing machine or dryer, look for the Energuide Label. This tells you the kilowatt hours (kwh) used per month. You can benefit the environment and possibly save money as the lower ratings reduce your electricity bill even if the initial purchase price is higher. Use fluorescent lights where practicable. Initial cost is again higher but the running cost is only one-quarter that of the standard light bulb. And consider dispensing with remote control on your new TV. According to the Rocky Mountain Institute in Colorado, up to 8 watts of standby power are used for a remote control even when it is turned off.

Energy conservation in the home must surely be a high priority for you. Stop air leaks with weather stripping, caulking around door frames, window frames, baseboards, fixture openings and attic hatches. Thoroughly insulate your attic, basement and walls if possible. Reduce excessive humidity, repair your leaking taps, install water savers on your shower head, lower the water cutoff level in your toilet, use air conditioners sparingly, if

at all, experiment with lower thermostat readings on your furnace and hot water tank and use timers. Every measure you take for conservation not only helps protect the environment but saves you money.

The use of environmentally friendly products can change the whole style and approach of your supermarket. Available now are 100% phosphate free detergents, toilet paper made from recycled paper, non-chlorine bleached reusable coffee filters (which saves on dioxine emissions), non-toxic cleaners such as the old-fashioned baking soda and organic pesticides. Dare I say that we should also cut down on our consumption of meat and eat more vegetables? Cattle production uses up far more resources than vegetable production for each unit of protein available.

THE FUTURE

We have examined the past and exampled some societies, both pre and post-industrial that were not sustainable. We have shown that what we are doing at the present has enormously accelerated the mistakes of the past by more widespread and more powerful technology. We have also shown the beginnings of a turnaround under the label of sustainable development. In this final section that looks to the next century we have to ask "Are we doing enough of the right things to prevent the destruction of our global habitat?".

Let us review the Brundtland definition [Overhead 4]. "Development Activity That Meets The Need of the Present Without Compromising The Ability of Future Generations to Meet Their Own Needs". We can note some immediate areas

that lack clarity, such as what kinds of "Development activity"; does it include nuclear weapons?: or "Needs of the present": does this encompass both material and spiritual needs?. But as I see it, there are two fundamental problems which the definition does not address for the 21st century. One is equitability and the other is population growth.

If we accept that an objective is to achieve equity for all nations, then we are confronted with some hard facts. One-fifth of the world's poorest population consumes only 2% of the world's GNP. One-fifth of the world's richest population consumes 75% of the world's GNP. Now if you somehow convince the richest not to get any richer and try to bring the rest up to the richest level, you have to increase the GNP by four times. But this increase would generate so much more waste heat that the globe would fry. The problem is now with us although the solution is not yet in sight.

Furthermore, the definition involves future populations: but what are the numbers? Look at this graph [Overhead 5]. Population was just one-quarter billion at the time of Christ. It didn't reach one billion until 1830. We have now passed the five billion mark and will be double that by the middle of the next century. Doubling population means doubling production which doubles waste heat generation even without doing anything to alleviate global poverty.

But we can accept the Brundtland definition as an interim measure as it helps solve immediate problems. It can be used to get all parts of our society to work together for environmental protection and conservation. This is a

necessary preconditon to face the problems ahead.

What then will our future society look like. I have just about time to offer this rough version before lunch. A relatively small, compact, community mostly self-sufficient to meet its cultural needs: it's connected electronically to major centres of industry and commerce, perhaps globally: there is no expensive commuting to work: owners, managers and the labour force work out production needs and problems together: consumerism will be less than it is today especially with water and energy but the goods we have will be more permanent and of better quality: the food we eat will be organically grown without the use of pesticides: our inner transportation needs will be met by public transit systems much superior and at lower costs than we have today: high speed rail links between cities will be increased: all forms of renewable energy sources will be widely used in our homes, offices, and factories and yes, in our cars.

In conclusion, I suggest that we accept the Brundtland definition of sustainable development for today because as Neil Armstrong said when he dropped in on the moon, "This is one small step for man but a giant leap forward for mankind." For tomorrow, we must broaden its base to include the issues of equitability and population growth. We do have the expertise and technology today to provide solutions and to turn things around. We have only to add political and economic commitment. In fact, we have a wonderful chance to do this today given to us by this time of military detente between the great powers. If we reap this peace dividend and make it work for the protection and conservation of our environment, we will surely create a more just, a more equitable, a more co-operative society for our children.

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BASIC RESOURCES ARISING

FROM OR DEPENDENT ON

LAND → ENERGY USE

WATER → ENERGY USE

AIR → ENERGY USE

BIOLOGICAL PREROGATIVE

PRESERVATION OF SPECIES

FLAURA AND FAUNA

HUMAN ENDEAVOUR

EQUITABLE DEVELOPMENT

POPULATION GROWTH

PEACE

GLOBAL ENVIRONMENTAL DETERIORATION

* TROPICAL RAINFORESTS DISAPPEARING
* SPECIES DISAPPEARING
* CORAL REEFS, WETLANDS DIMINISHING
* SOIL EROSION AND DESERTIFICATION
* OZONE LAYER DEPLETION
* GREENHOUSE BUILDUP
* OCEAN POLLUTION
* ACID RAIN
* MAJOR SPILLS

SUSTAINABLE DEVELOPMENT

A FORMULA

$$\text{SUSTAINABILITY} = \frac{\text{RESOURCES}}{\text{DEPENDENT LIFE}}$$

RESOURCES: FORESTS
AGRICULTURAL LAND
LAKES, RIVERS,
OCEANS
AIR (QUALITY,
CLIMATE)

DEPENDENT LIFE: HUMANKIND
ANIMALS
FLAURA
FAUNA
BIOLOGICAL PROCESSES

SUSTAINABLE DEVELOPMENT

- BRUNTLAND DEFINITION

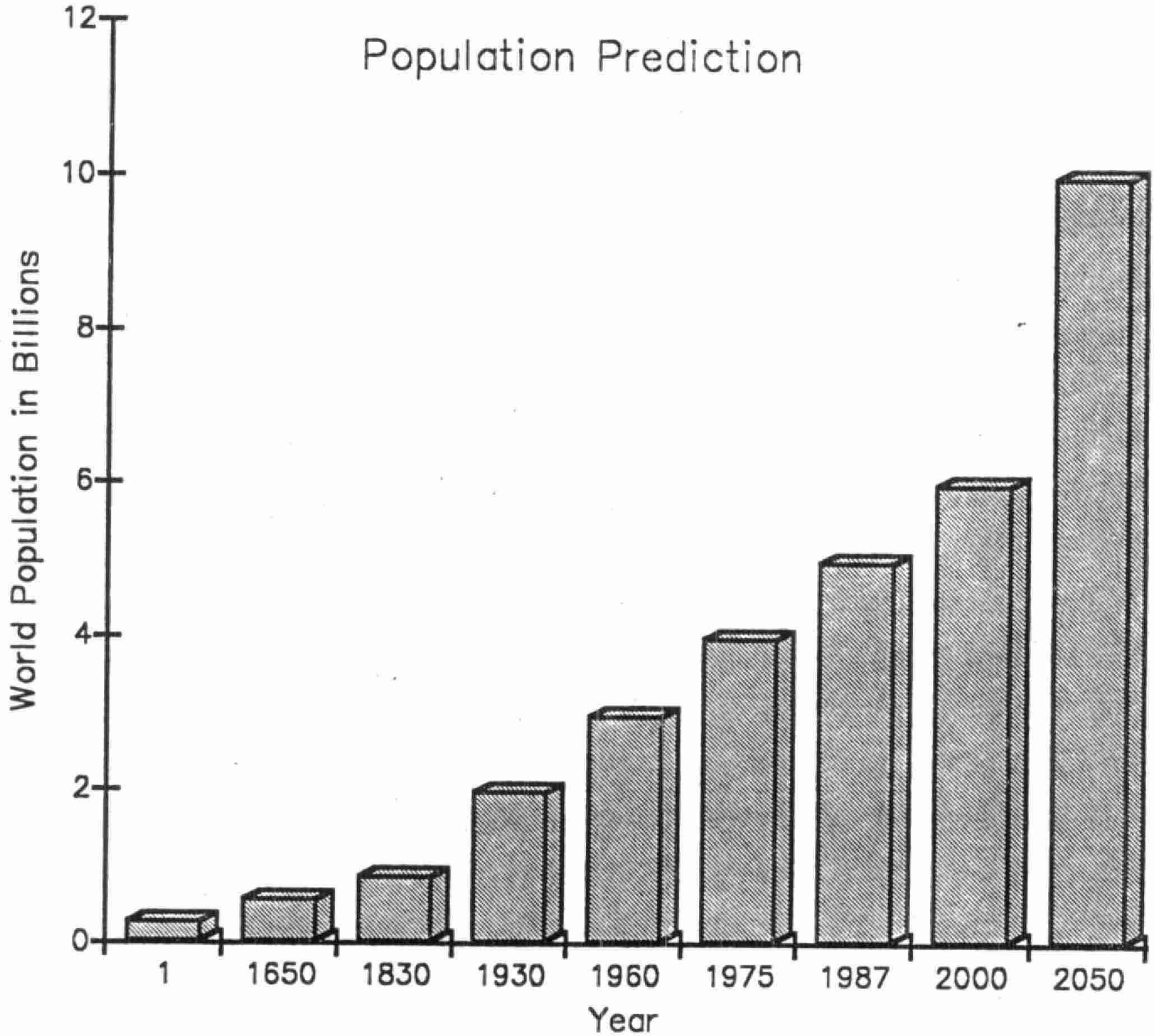
"DEVELOPMENT ACTIVITY THAT MEETS

THE NEEDS OF THE PRESENT WITHOUT

COMPROMISING THE ABILITY OF

FUTURE GENERATIONS TO MEET

THEIR OWN NEEDS"


Population Prediction
World Population in Billions
0
2
4
6
8
10
12
1
1650
1830
1930
1960
1975
1987
2000
2050
Year

INNOVATIVE METHODS FOR SEPTAGE COLLECTION AND DISPOSAL

Blake Dawdy
Northland Engineering
North Bay, Ontario

1.0 Introduction

1.1 Authorization

In June of 1989, Northland Engineering (1987) Limited was engaged by the Ontario Ministry of the Environment and the Ministry of Northern Development and Mines to examine the feasibility of introducing various innovative mobile septage collection and disposal systems. The terms of reference for this project are included in the Appendix.

The prime objective of this assignment was to identify a potential septage management system which would minimize adverse environmental impacts from septic tanks and tile beds and the disposal of the residuals from these systems.

In support of the prime objective, the following steps were undertaken:

a) the existing septage management system was identified and evaluated;

b) the existing septage generation rates and changes which could modify these rates were identified; and

c) alternative septage collection and disposal systems currently being successfully operated in other jurisdictions were evaluated with their potential for application in Northern Ontario and in particular the North Bay area.

Because of the extensive research and experience with such systems in other jurisdictions, most information on the systems has been collected from published literature. It was also possible to visit the location of one of these operations at Sainte-Agathe-des-Monts, Quebec.

1.2 Background

Increasing environmental concern and changes in lifestyles associated with rural living have focussed attention on rural sewage disposal systems.

The most widespread type of rural sewage disposal system is the conventional septic tank and tile bed. The popularity of these systems is due both to their low cost, the lack of alternatives and their relative effectiveness.

The basic treatment processes operating in a septic tank and tile bed system are the settling of solids and coagulation of greases within the septic tank, the biologic treatment of organic matter in the liquid in the tile bed, and the dispersion of the treated liquid to the subsurface water table .

For effective operation of these systems solids and grease must be trapped in the septic tank. If solids and grease are allowed to enter the tile bed, the tiles soon become plugged and the tile bed fails.

Although anaerobic digestion reduces the volume of solids within the tank, over a period of time the buildup of grease on the surface and digested solids in the bottom of a septic tank reaches a volume where they must be removed to ensure continued successful operation of the system. Depending on the size of the septic tank, and the nature of the inflows, this typically is required every 1 to 5 years. (The lower figure applies to large commercial systems.)

Nutrient removal by conventional septic tank and tile bed systems is limited to the settling of solids in the tank and adsorption by soil particles down gradient of the tile bed system.

Removal of grease and digested solids from a septic tank is typically undertaken by a vacuum pump into a steel storage tank mounted on a truck. All the contents of the septic tank are removed including the liquid present in the tank at the time of pumping.

The pumped material, known as *septage* is then trucked away for disposal at either a septage lagoon, a municipal sewage treatment plant, or some other approved site.

Frequent pumping of septic systems is desireable for a number of reasons, including:

o the prevention of grease and solids from reaching the tile bed;

o the reduction of nutrient levels in the liquid entering the tile bed; and

o the effective inspection of system performance.

Because of the cost associated with a pumpout ($80-$85), the widespread lack of knowledge of the need, and the lack of regulatory requirements, the septic tanks of many systems are not pumped as frequently as is desireable. In a recent survey of septic systems on Trout Lake, (ref. 16) 157 of 317 systems five years or older had not been pumped within the last five years.

In other jurisdictions, a compulsory requirement for septic tank pumpout exists. For example in the Province of Quebec, permanent residences are required by law to be pumped out at least every two years while seasonal residences require pumpouts at least every four years.

The principal destinations of pumped septage in Ontario are:

o Municipal sewage treatment systems;

o Septage exfiltration lagoons;

o and Agricultural Land.

Disposal of septage is a significant and growing problem. The problems associated with current methods of disposal include:

o the upsetting of plant processes particularly in smaller municipal treatment plants caused by its relatively *strong* nature;

o environmental and aesthetic concerns particularly with regards to degradation of groundwater associated with septage disposal lagoons; and

o it's liquid nature, odour, pathogenic nature, possible heavy metal content, and the grit, grease, and hair contained in it which together constitute both a regulatory and practical problem for land disposal.

This constitutes a classic environmental conundrum in that more frequent pumping is desireable from a number of environmental perspectives but the disposal of the material has significant adverse environmental effects.

2.0 Mobile Septage Sludge Dewatering

2.1 Concept of Mobile Septage Dewatering

The idea behind mobile septage dewatering is that only the solids and greases contained in the septic tank need to be removed to ensure effective operation of the system.

The solids content of septage is generally estimated to comprise 2% of the total volume of septage in a septic tank. The liquid portions of the septage can in principle be properly treated by tile beds. Therefore mobile septage dewatering is intended to minimize the removal of the liquid fraction of septage while maximizing the removal of the solid fraction of septage.

Obvious benefits of septage dewatering are:

- o a reduction in the total volume of waste collected;
- o an increase in the number of septic systems that can be pumped on a given trip; and
- o a reduction in the cost of septage pumping.

A less obvious but equally important benefit is that dewatered sludge is easier to handle and allows consideration of alternative disposal schemes.

2.2 Description of Mobile Septage Sludge Dewatering Systems

2.2.1 Fossetic system

The Fossetic system was developed by Maurice Poulin, P.Eng. of Envirosol, Sainte-Agathe-des-Montes, Quebec in the early 1980's. (ref. 7,8,&9)

Three different layers or phases of material occur in a septic tank. The bottom layer consists of the settled *solids*. Above this layer is the liquid which is discharged to the tile bed. Finally on the top is a layer of grease and scum. Of these materials only the settled solids and the grease layer need to be removed during pumpouts to ensure continuing satisfactory performance of the system. When a tank is ready to be pumped, the settled solids and grease occupy about 30 to 35% of the total tank volume.

The Fossetic system is described aptly as *the selective pumping technique.* The pumpout truck is modified so that a baffle separates the tank into two chambers. The operator uses a transparent hose to suck the separate fractions of the septage into their respective chambers. Initially the crust formed by the scum and grease is broken and the largely liquid fraction is pumped. Because the hose is transparent, the operator can easily determine when the largely solid fraction is being pumped and switches to the second compartment of the truck. Because the liquid is removed, the surface layer of grease and scum has settled on the solids. Once the solids and grease fractions are removed, the liquid portion is returned to the septic tank.

The volume of septage removed from the system thus comprises only 30-35% of the total volume of septage contained in the tank unlike the 100% volume removal of the conventional system.

The modifications required to an existing truck consist of:

a) the installation of a plate in the tank of the truck to form two isolated compartments (a front compartment of approximately 4000 litres for the temporary storage of liquid and a rear compartment for retaining the solid fraction);

b) the installation of piping and valving allowing switching of intake and discharge between the two compartments; and

c) the installation of a high capacity vacuum pump if not already installed (minimum of 500 C.F.M., 600 C.F.M. recommended).

This system is patented in Canada and the United States. Because of funding provided by Environment Canada, the royalties are quite modest. Existing arrangements in Quebec are for a franchisee to be granted an exclusive license for an area for a royalty fee of $1.00 per septic tank in the area.

The costs of retrofitting existing trucks for *selective pumping* reported by two independent franchisees were between $2,000 and $2,500 for the plate and piping with an additional $7,500 required to retrofit one of the trucks with adequate vacuum pumps. For comparison purposes the estimated capital cost of a new system is $60,000 plus a suitable truck chassis. For comparison purposes a new conventional tank and related equipment costs about $45,000.

The septage obtained from *selective pumping* is being composted with sawmill wastes to create a topsoil additive. More details of this procedure are described in the section on septage disposal options.

2.2.2 Hamstern

The Hamstern system was developed by Marstrands Vatten-och Avloppstekniska AB, of Marstrand, Sweden in the late 1970's. (ref. 3,4,5 &10)

The process consists of pumping the raw septage from a septic tank into a receiving tank. Filtered liquid from the previously pumped septic tank is discharged to the just pumped septic tank.

The septage is then dosed with lime and transferred to a vacuum/mechanical filtration dewatering system. The dewatered sludge is transferred to a sludge cake container, while the filtered liquid is transferred to a holding tank for discharge to the next septic tank.

Dosage rates with lime are approximately 4 kg of $Ca(OH)_2$ per cubic metre of septage.

The solids content of the dewatered sludge cake is estimated at 20%. Only about 10% of the original volume of septage is removed from the tank to be trucked away for disposal.

Capital costs of the dewatering unit are not available from the manufacturer but reference to a previous evaluation indicates a capital cost of approximately $400,000 plus the cost of an appropriate truck chassis.

Dewatered sludge after being stabilized by lime is generally disposed of to agricultural land. Because the pH of the sludge is temporarily raised to 12 by the addition of lime virtually all pathogenic bacteria and viruses are destroyed.

2.2.3 Moos KSA

The Moos KSA system was developed by Simon Moos Maskinfabrik ApS of Sonderborg, Denmark in the early 1980's. (ref. 4,10,&14)

The process consists of pumping all of the septage from a given septic tank into a receiving tank. The filtered liquid from a previously pumped tank is discharged to the just pumped septic tank as in the Hamstern system.

The septage is then conditioned with a commercial polymer. The polymer conditioned septage is pumped into the dewatering tank and assists the settling of solids. This tank consists of a side wall drainage system covered by filter fabric. The supernatant liquid is filtered by gravity through the side walls.

The required dosage rate of polymer is approximately 150 g/m^3 of raw septage.

The solids content of the dewatered cake is approximately 15%. Only 13% of the original volume of the septage in the septic tank needs to be taken offsite for disposal.

Costs quoted for this equipment by the manufacturer were approximately $175,000 Canadian depending on currency exchange rates. In addition to this, a suitable truck chassis would be required.

Dewatered sludge from this process is generally disposed of on agricultural land either with or without lime stabilization.

2.3 Comparison of Systems

2.3.1 Impacts of Disposal Options on Comparison

In comparing the relative merits of these systems it is important to realize that the intended means of disposal is critical. In view of the waste management problems currently being experienced throughout Ontario, the means of disposal may be the overwhelming criteria for selection of a system. All three systems reduce the total volume of waste to be treated offsite.

If current disposal practises remain the only viable disposal options then there is little point in examining either of the Scandinavian systems since the dewatered sludge is unsuitable for disposal either at a septage lagoon or a municipal waste water treatment plant. The dewatered sludge from the Fossetic system might be marginally suitable for conventional disposal techniques.

Conversely if land application for agricultural purposes is the preferred disposal option, then the Scandinavian systems appear to be the best alternatives.

If a form of composting with sawmill wastes or other material is the preferred disposal option, then the Fossetic system is the preferred system.

2.3.2 Reduction of Nutrients

Under conventional operations little nutrient reduction can be anticipated for any of the alternatives considered. Paulsrud and Eikum (ref. 4) report that the residual lime from the Hamstern process may improve the phosphorus removal efficency of the septic tank system during a period after filtrate return.

Measurements made by Brandes (ref. 6), indicate that only 4.3% of the phosphorus input to a conventional system over a 16 month period was retained in the sludge. This suggests that even very frequent pumping of conventional septic tank systems can have only a very modest effect on nutrient levels.

One proposal, under active consideration in the Trout Lake Pollution Control Planning Study (ref. 16), is to retrofit existing septic systems with an alum precipitation system. Measurements by Brandes (ref.6), indicate a range of 70% - 85% of all phosphorus entering a septic tank was precipitated by alum injection. This same study measured a 2.3 times increase in the rate of sludge generation. Details of this proposal are described elsewhere in this report.

If the favourable findings with regard to phosphorus reduction are borne out by further work, mobile septage dewatering systems may play an important role in handling the increased sludge generation due to adoption of the alum injection phosphorus managment technique.

2.3.3 Effect on existing systems

In reviewing the potential impact of the dewatering systems on the septic system, our original concern was that the pumping process might result in the resuspension of previously settled solids and a resulting shock load of suspended solids to the tile bed. This shock load could significantly shorten the tile bed's service life by clogging the tiles with solids. Review of the available information indicated that this was not found to be a significant problem for any of the three systems examined.

Specific comments relative to each system are:

The Fossetic system by reducing the total volume of septage in the septic tank by 30-35% provides a buffer period, during which no effluent discharges to the tile bed, while this volume is replenished by inflow. During this buffer period, typically at least three hours, resuspended solids have an opportunity to settle out. Measurements undertaken by Poulin indicated that after 3 hours the suspended solids concentration of the liquid in the septic tank was within 15% of the original concentration prior to pumping (230 mg/l versus 200 mg/l originally).

The suspended solids of the filtrate from the MOOS KSA system is reported to be in the range of 200-300 mg/l (ref. 4&10). As much as 87% of the original septage volume is returned to the septic tank. This means that little time is available for the settling out of resuspended solids, while the tank refills to the level where it will discharge to the tile bed, . Because of the suspended solids level of the returned liquid, this should not cause a significant problem for the tile bed.

The filtrate from the Hamstern system is reported as averaging a suspended solids level concentration of 1000 mg/l (Paulsrud & Eikum) significantly higher than the other two systems. The authors state:

> "*no negative effect so far has been reported, and investigations in Sweden have shown only a minor increase in suspended solids out of the septic tank 1-3 days after filtrate addition.* " (ref. 4)

Despite this statement, there is some potential concern. Since 90% of the original septage volume is returned to the septic tank with the Hamstern system, little time exists for settling of the resuspended solids before the liquid from the tank discharges to the tile bed. Consequently, there is the potential for a short term impact on the tile bed.

Both the MOOS KSA system and the Hamstern system return the filtered liquid from a previously pumped to the system that has been just pumped. The potential therefore exists for passing contaminants from one system to another. A hypothetical scenario is that surplus medicine is poured down the drain of one house killing the digesting bacteria in the septic tank and the contaminated liquid is passed on to the next house to repeat the killoff. While not a likely occurrence, this is an example of the sort of problem that may arise.

Although the filtration time of the Hamstern system (approximately 15 minutes) would be sufficiently short to allow return of a given tanks liquid, the MOOS KSA system because of its gravity filtration method would require too long a period (in excess of an hour) to allow return of the liquid to the tank from which the septage has been pumped.

The Fossetic process intrinsically treats each system's liquid individually.

2.3.4 Cost Analysis

The following cost analysis (Table I) of the various systems was undertaken using the best information available.

Table I

Cost Analysis of Various Septage Collection Systems

	Unit	Hamstern	Moos KSA	Fossetic	Conventional Vehicle
Unit Costs					
Capacity	m^3/day	45	35	45	25
Volume of tank	m^3				13.5
Labour Cost	$/day	$160	$160	$160	$160
Chemicals	$/$m^3$	$0.75	$1.00	$0.00	$0.00
Fuel, vehicle	$/km	$0.23	$0.23	$0.23	$0.23
Fuel, dewatering	$/day	$35	$5	$0	$0
Servicing vehicle	$/km	$0.12	$0.12	$0.12	$0.12
Maintenance	$/day	$30	$23	$12	$12
Insurance	$/yr	$5,000	$5,000	$4,000	$3,750
Capital Costs					
vehicle chassis	$	$45,000	$45,000	$45,000	$45,000
collection equip.	$	$400,000	$175,000	$60,000	$45,000
Depreciation					
vehicle	years	5	5	5	5
collection equip.	years	10	10	10	10
Unit Quantities					
working days	#	48	60	48	80
units per day	#/day	10	8	10	6
di	disposal trips	#/day	1	1	1
disposal mileage	km	120	120	80	50
mileage per call	km	3	3	3	3
annual mileage	km	7200	8640	5280	9440
Cost Analysis Breakdown					
fuel/maint.	$	$5,618	$4,645	$1,848	$4,265
chemical cost	$	$1,620	$2,100	$0	$0
labour cost	$	$7,680	$9,600	$7,680	$12,800
capital cost	$	$66,425	$35,075	$19,052	$16,963
insurance	$	$5,000	$5,000	$4,000	$3,750
royalties	$	0	0	$480	0
Total Cost	$	**$86,343**	**$56,421**	**$33,060**	**$37,777**
Per Unit Cost	$	**$180**	**$118**	**$69**	**$79**
units per year	#	**480**	**480**	**480**	**480**

*** Note: Disposal charges and/or costs are not included

A number of costs such as labour rates, vehicle mileage, actual distance travelled, and depreciation rates can only be assumed. Key assumptions include a labour rate of $20 per hr., mileage of 38 litres per 100 km., and a real interest rate of 7%. These estimates appear to be fairly realistic as the cost per unit for a conventional vehicle is $79, compared to the $80 currently charged by haulers.

Controversial estimates include the distance of travel for disposal and distance between calls. Because of the lack of availability of agricultural land for disposal in much of the watershed, an arbitrarily high disposal mileage has been assigned to the systems relying on sludge disposal. Disposal to the municipal system is central to this area and has the lowest arbitrary mileage. It is assumed that a central composting facility would be required and that the location would not be as central as the North Bay municipal system because of siting constraints.

2.3.5 Summary of Comparisons

Table II summarizes the key features of each of these systems.

Table II

Comparison of Alternative Septage Collection Systems

	Fossetic	Hamstern	Simon Moos
% Reduction in Septage Collected	70.0%	90.0%	87.0%
Solids Content of Sludge	6.7%	20.0%	15.0%
Nutrient Removal (without alum)	No	Some	No
Destruction of Pathogens	Yes with composting	Yes	Yes with lime
Suitability of Sludge for Agricultural Use	somewhat suitable	quite suitable	quite suitable with lime stabilization
Suitability of Sludge for Composting	quite suitable	not suitable	not suitable
Potential impact on Tile Bed	No	Possibly	No
Transfer of Liquid Between Systems	No	Yes	Yes
Chemicals Required	None	Lime	Polymer
Estimated Capital Cost (including truck)	$105,000	$445,000	$220,000
Estimated Operating Cost Per Unit Pumped	$69	$180	$118

2.4 Required System Modifications

Currently septic tank access hatches are generally buried about 150 mm below the ground surface. The reasons for this practise are probably threefold.

1) safety against unauthorized access;

2) to prevent odours from escaping from the tank; and

3) for aesthetic reasons.

The disadvantages of this practise are:

1) additional effort is required at pumpout time to locate and excavate the access hatches as well as the need to backfill and restore the ground cover after pumping; and

2) new owners may be unsure of the septic tank location or even unaware of its existence.

If more frequent pumpouts of a septic system are to be undertaken, it would be advantageous to facilitate access. Alternatives that could be considered are a standard waterproof sanitary sewer manhole chimney, frame and cover or the standard chimneys and covers used on buried commercial gasoline tanks. These types of cover are recommended both for safety and odour reasons. An added advantage of a readily removeable cover is that septic systems can be inspected in a much easier manner.

While some homeowner resistance might be encountered to a visible access to the tank, the disruption to lawns from an annual excavation of the access hatches should persuade most that this is a desireable change.

The cost of such modifications to an existing or a proposed system is estimated to be approximately $500.

2.5 Nutrient Removal Systems

A major concern associated with lakefront properties on septic tanks and tile beds is the introduction of phosphorus to the lake. The biological activity or trophic status of most lakes in Ontario is determined by the concentration of phosphorus in the waters. High phosphorus levels lead to a lower water quality.

Phosphorus is relatively rare in natural settings and it is common for lakes with significant shoreline development to have more half of the phosphorus introduced to the lake originating from septic systems.

Conventional septic systems and tile beds are not effective treatment techniques for phosphorus removal. Some phosphorus removal occurs from the settling of solids in the septic tank and their consequent removal by pumping. Measurements by Brandes (ref. 6) indicated 4.7% removal by this method on a test conventional system.

The other process which slows phosphorus from reaching the lake is the adsorption of phosphorus to fine particles in the soil from the liquid discharging from the tile bed to the lake. In sandy or rocky soils with little fine soil particles or a thin layer of water saturated soil above bedrock, the capacity of the soil to adsorb phosphorus is quickly exhausted. Even on better sites the ability of soils to adsorb phosphorus is limited and within a matter of decades no phosphorus retention occurs.

A potential solution to this problem is the incorporation of alum precipitation systems in the plumbing of residences relying on septic systems for disposal of waste water. This solution was first investigated by Brandes (ref. 6). The basic technique is to inject aluminum sulfate (alum) into the waste water stream on a flow proportional basis. The alum chemically bonds with the phosphorus to form the low solubility solid Aluminum Phosphate. The aluminum phosphate precipitates out of solution and settles to the solids in bottom of the septic tank. Consistent results of 80-85% removal were reported by Brandes.

The stochiometric equation for this process is as follows:

$$Al_2(SO_4)_3 + 2PO_4^{-3} \text{ -> } 2AlPO_4 + 3SO_4^{-2}$$

The pilot system installed by Brandes for his investigations used a mercury float switch similar to that used on thermostats to sense movement on the flushing handle of the toilet in the residence and introduce a fixed amount of alum into the system. Since the alum was injected at the same time as the waste water, good mixing occurred within the plumbing prior to reaching the septic tank.

Toilet wastes are currently estimated to contribute 0.6 kg/cap/yr to a septic system, miscellaneous household uses an additional 0.2 kg/cap/yr and automatic dishwater detergent in houses so equipped an additional 0.6 kg/cap/yr. In view of the multiplicity of sources of phosphorus discharging to a household's plumbing, a flow sensor installed on the main discharge pipe appears to be more suitable as an activating device.

The proposed system would consist of a flow sensor on the main drain pipe activating a chemical dosing pump mounted on a small drum of liquid alum concentration.

Brandes reported maximum phosphorus removal at an aluminum to phosphorus ratio of 2:1. Based on a per capita Phosphorus loading to the septic system of 1.4 kg/cap/yr (ref. 16), approximately 18 kg of alum per year per person would be required. Alum can be obtained in 45.5 litre containers of liquid alum containing 29.58 kg of dry alum. Thus two containers would be sufficient for a 3 person residence per year.

The estimated cost of the alum on an annual basis is 75$ per household while the cost of the flow sensor and chemical feed pump is estimated at $500 per household.

One possible scenario for the operation would be for a municipally operated system, where the containers, with a chemical feed pump integral in their lids, would be replaced on a regularly scheduled basis, allowing shop servicing and inspection of the chemical feed pump.

Brandes reported that sludge accumulation was 2.35 times greater with the alum precipitation system. Consequently there is a need for more frequent septage pumpouts with this system as well as a greater volume of septage to be disposed of.

Potential issues which need to be resolved before an alum precipitation system is implemented on a large scale include:

o how are the greater volumes of septage to be handled? (i.e. are mobile septage dewatering and related disposal options appropriate?)

o what is the potential impact of the residual alum and sulfates on soils, aquatic life, terrestrial plant life, and humans?

o what are the best mechanical and operating arrangements for such a system?

o are there any potential problems with the aluminum phosphate in the septage?

3.0 Septage Disposal

3.1 Septage Volumes

Septage volumes and means of disposal within the North Bay District and Parry Sound Subdistrict of the Ministry of the Environment have recently been reviewed by district staff. The preliminary findings of this review (ref. 15) are presented in the following table.

Table III

Septage Haulage Survey - 1989 North Bay Area Haulers

Volume of Liquid Hauled and Method of Disposal

Hauler	Locale	North Bay Sewage Treatment Plant	Exfiltration Lagoons	Farm Fields	subtotals
Becker	Trout Creek			3000	3,000
Carriere	East Ferris	112,500	337,500		450,000
Dutrisac	Springer			20,000	20,000
Chapentier	Lavigne		400,000		400,000
Lafrenier	Springer		600,000		600,000
Seguin	North Bay	2,069,000	11,000		2,080,000
Phippen	North Bay	200,000			200,000
Trottier	Callander	749,860			749,860
	subtotals	3,131,360	1,348,500	23,000	
		69.54%	29.95%	0.51%	4,502,860

Note: All figures are given in imperial gallons

Approximately 50% of the waste liquid disposed of is assumed to be the contents of holding tanks and comprises few special handling or disposal problems. Holding tank waste is not suitable for septage dewatering. The balance of the waste liquid (some 2.25 million gallons or 10,250 cubic metres) comprises septage. Assuming that the same proportion of septic tanks are pumped on an annual basis, this can be taken to be the current septage generation rate within the area.

Within the area serviced by these haulers reside some 21,000 permanent residents who are not serviced by a municipal sewer system. Typical per capita septage generation rates used in the United States (ref. 1) vary from 190 to 380 litres per capita of septage per year. This yields a range of 4,000 to 8,000 cubic metres for anticipated septage generation in this area. The discrepancy is likely accounted for by the large number of seasonal residents and visitors to this area.

Based on the findings of the Trout Lake Pollution Control Plan (ref. 16), average septic tank pumpout frequency can be estimated currently to be about once every five years. In the future, pumpout frequency is likely to increase either by regulation or because of the increased environmental consciousness of residents.

The Trout Lake Pollution Control Plan recommends municipally enforced annual pumpouts of all septic systems within the watershed. If such pumping frequency were undertaken in the entire North Bay area, annual septage generation rates will increase five fold.

Another key recommendation of the Trout Pollution Control Plan is that alum precipitation units to reduce phosphorus in the effluent be retrofitted to all septic systems in the watershed. This is anticipated to increase septage sludge generation rates to 2.5 times current rates.

Population in the North Bay Area over the past decade has shown a slight decline. Although recent economic conditions have stabilized population, little or no growth is anticipated in the near future. Taking into account all of the foregoing, it is anticipated that raw septage volumes generated within the North Bay Area could increase to between 30,000 and 50,000 cubic metres annually within the next five years.

3.2 Nature of Septage

As described earlier, septage is a difficult material to handle. Septage contains significant amounts of pathogenic organisms, nutrients, oxygen-demanding materials, grit, grease and hair. The characteristics of raw undewatered septage are summarized in Table IV.

Table IV

Comparison of Septage and Domestic Sewage

	Design Septage Values	Design Domestic Sewage Values	Ratio Septage to Domestic Sewage
Total Solids	40000	700 -1000	40 - 57
Total Suspended Solids	15000	180 - 300	63 - 83
B.O.D.5	7000	160 - 280	32 - 44
Chemical Oxygen Demand	15000	550 - 700	24 - 27
Total Kjeldahl Nitrogen	700	40 - 50	16 - 18
Ammonium-Nitrate	150	25 - 30	5 - 6
Total Phosphorus	250	10 - 15	20 - 25
Alkalinity	1000	100 - 125	9 - 10
Grease	8000	90 - 110	80 - 89

1 All values expressed in mg/L
2 Design Septage Values from U.S. EPA "Manual of Septage Practise" (ref. 1)
3 Design Domestic Sewage Values from U.S. EPA "Wastewater Treatment Facilities for Sewered Small Communities" (ref. 12)

3.3 Current septage disposal practises

The principal means currently employed for disposal of septage in the North Bay Area are either discharge to the Municipal Sewer System at North Bay (70%), or to privately operated septage lagoons (29.5%). Additionally small quantities (0.5%) are disposed of to agricultural fields. (ref. 15)

While each of these methods have been practised successfully in a number of jurisdictions, without proper techniques, facilities, and controls, each method can have serious environmental impacts.

3.3.1 Disposal to Municipal Sewer System

Hauled sewage including septage is discharged to the North Bay sewer system approximately 1 kilometre upstream of the sewage treatment plant at a designated manhole. This manhole is located on a trunk sewer servicing approximately 8,000 people in the northwest corner of the city. In 1989, approximately 7,100 cubic metres of septage was discharged to the City sewer system.

Because of climatic conditions, virtually all pumping of septage except for emergency situations is undertaken during the months of May through October. Average daily flows for the North Bay Sewage Treatment Plant for the months of May through October in 1987 and 1988 averaged 25,360 cubic metres (ref. 13). A summary of the impact of septage discharge on the plant is as follows:

Table V

Impact of Septage Disposal on the North Bay Sewage Treatment Plant

Parameter	Increase	Impact on Operating Costs
Flow	0.15%	nominal
Suspended Solids	9.7-12.8%	additional sludge handling costs
BOD_5	4.9-6.8%	increased energy consumption
Total Phosphorus	3.1-3.8%	increased chemical and sludge handling costs
Grease	12.3-13.8%	increased maintenance and sludge handling costs

Note: Increases are expressed as a percentage of total loading to the plant

The average daily discharge of septage may at times exceed these increases by as much as 4 times. The result is potential disruption of the activated sludge process.

The application of German guidelines (ref. 1) to the North Bay S.T.P. suggest that 20 cubic metres of septage per day can be accomodated. Other published guidelines (ref. 1) suggest that approximately 168 cubic metres of septage can be accomodated without adverse affects on the treatment process. Estimated average daily septage inputs for the North Bay area are 39 cubic metres or approximately 4 haulage trucks. Peak discharges are estimated at 156 cubic metres per day or some 16 haulage truck loads.

The wide range in accepted values for amounts of septage that can be safely discharged to a municipal system reflect the prevailing uncertainty on the potential impact. Generally throughout the 1987-1988 period, the North Bay S.T.P. was found to comply with the provincial effluent requirements for suspended solids and BOD_5 while slightly exceeding the objective for phosphorus in effluent (ref 13). Consequently, the plant can be assumed to be accepting existing septage loads satisfactorily.

However, the potential increase in septage discharge volumes by a factor of 3 to 5 is likely to result in considerable disruption to the plant process and associated problems with meeting provincial discharge criteria.

3.3.2 Septage Lagoons

Septage Lagoons, in the North Bay area, receive approximately 29.5% or 3100 cubic metres of septage annually with an additional 3100 cubic metres of holding tank contents.

Septage lagoons are designed to act as exfiltration ponds with the liquid infiltrating to the soil. The principal water quality concern associated with the operation of lagoons therefore is the potential impact on groundwater resources and in particular nitrates. In practise, nitrates concentration is the governing criteria in evaluating the impact of septage lagoons on groundwater.

The provincial water quality objectives require a maximum concentration in groundwater of 10 mg/L for nitrates. Allowance for background nitrate concentrations, and the rights of downstream property owners to use the groundwater for disposal, under the Ministry of the Environment's *reasonable use policy*, mean that only a portion of this 10 mg/L is available for dilution.

Assuming that all of the typical 700 mg/L of Total Kjeldahl Nitrogen is oxidized to nitrates, the potential nitrates concentration of septage is 3100 mg/L. Assuming that 5 mg/L of nitrates is the allowable discharge and neglecting the attenuation mechanisms of soils and nitrogen uptake by intervening vegetation, a dilution ratio of 620:1 is required for the long term compliance of lagoons.

Using a typical infiltration rate of 200 mm/yr of precipitation to the soil, approximately 3100 (1/.2 x 620) square metres of land area is required for the dilution of 1 cubic metre of septage. On an annual basis, therefore 3100 x 3100 or 962 hectares of land is required for current septage generation rates and disposal in the North Bay area.

Other problems associated with septage lagoons are odours, visual aesthetics and insects.

In summary, although lagoon operations can be controlled in such a manner as to minimize environmental impacts outside property limits, lagoons are generally an inefficient means of septage disposal for reasons including:

- o the neutralization of land due to contamination;
- o potential impacts on groundwater; and
- o objectionable odours and visual aesthetics.

3.3.3 Disposal of Septage to Agricultural Lands

The disposal of septage to agricultural lands attempts to utilize the nutrients in septage as a fertilizer. Septage is quite similiar to sewage treatment plant sludge in many of its characteristics although much lower in heavy metals. In the North Bay area, septage sludge is generally applied to fields used for hay and haylage.

Ontario's Guidelines for Sewage Sludge Utilization on Agricultural Lands (ref. 2) have been adopted as the basis for examining the suitability of raw septage for agricultural land application. Raw septage is judged to be a fluid anaerobically digested sludge.

Key rationale behind these guidelines are:

a) Ammonia nitrogen application rates should not exceed the potential plant requirements for nitrogen in order to minimize the potential for nitrate contamination of groundwater; and

b) The heavy metals contents of the soils should not be allowed to exceed recommended levels in order to prevent the entrance of heavy metals into the food chain.

As a consequence, the ratio of ammonia-nitrogen to a heavy metal governs the suitability of a given septage for application to agricultural land.

The following table examines the general suitability of septage using United States Environmental Protection Agency design values (ref. 1) for heavy metals concentrations in septage for application to agricultural lands.

Table VI

Suitability of Septage for Agricultural Land

	Raw Septage Metals Contents Design Concentrations(ref.1)	Ratios Ammonia - Nitrogen to Metals	
		Design	Guideline(ref.2)
Arsenic	0.20 mg/L	750	>100
Cadmium	0.70 mg/L	214	>500*
Cobalt	no data		
Chromium	1.0 mg/L	150	>6
Copper	8 mg/L	19	>10
Mercury	0.25 mg/L	600	>1500*
Molybdenum	no data		
Nickel	1 mg/L	150	>40
Lead	10 mg/L	15	>15
Selenium	0.1 mg/L	1500	>2800*
Zinc	40. mg/L	3.8	>4*

Note: * indicates a violation of the provincial criteria

From this table it is apparent that a design raw septage exceeds criteria for several critical heavy metals including Cadmium, Mercury, Selenium, and Zinc. The contents of septage can vary significantly from locale to locale. However the potential exists for violation of these criteria particularly in the cases of Mercury and Selenium.

Pathogenic viruses and bacteria are also present in abundance in raw septage (ref.2) a significant health hazard to any persons coming in contact with the septage.

Direct disposal of raw septage on agricultural land therefore has the potential to introduce undesireable quantities of heavy metals to the food chain and pose health hazards to persons.

3.4 Alternative Septage Disposal Schemes

In the course of this study two alternative septage disposal schemes have been considered:

a) disposal of dewatered stabilized sludge to agricultural lands; and

b) composting of septage with wood waste.

Both of these schemes require special collection techniques to reduce the volume of septage handled and to render the septage suitable for disposal. The associated collection techniques have been discussed previously and are respectively the Hamstern and Simon Moos systems for agricultural disposal and the Fossetic system for composting. The following sections deal specifically with each system.

3.4.1 Dewatering and Stabilization of Sludge for Agricultural Land Disposal

As discussed previously raw septage has undesireable characteristics for direct application to agricultural lands. These characteristics include the potential heavy metal contamination of lands and the potential health hazards to persons from pathogenic bacteria and viruses.

The Scandinavian systems dewater the septage to minimize handling problems and use lime stabilization to raise the pH to approximately 12 in order to eradicate all pathogenic bacteria and viruses. The resulting sludge can be regarded as a Dried and Dewatered Anaerobic Sludge.

Information on the metals content of the Hamstern sludge along with the appropriate Ontario criteria are presented in the following table.

Table VII

Hamstern Sludge Analysis (ref.3)

Dry Solids	25.60% DS
Ammonium Nitrogen	0.11% DS
Nitrate	<0.01% DS
Total Phosphorus	0.70% DS
Potassium	0.02% DS
Calcium	18.80% DS

	Measured Concentrations	**Provincial Objectives(ref.2)**
Mercury	0.4 mg/kg DS	11 mg/kg
Cadmium	1.2 mg/kg DS	34 mg/kg
Lead	1.6 mg/kg DS	1100 mg/kg
Chromium	7.4 mg/kg DS	2800 mg/kg
Cobalt	<3 mg/kg DS	340 mg/kg
Nickel	5.9 mg/kg DS	420 mg/kg
Copper	105 mg/kg DS	1700 mg/kg
Zinc	390 mg/kg DS	4200 mg/kg

It should be noted that unlike raw septage this product is very low in metals relative to provincial criteria. In addition the lime stabilization eliminates the health hazards associated with viruses and bacteria. Although, the Hamstern sludge contains the same amounts of heavy metals, its enrichment ensures that adequate amounts of fertilizer are applied to a field unlike an unstabilized raw sludge.

No information on the content of the Simon Moos Sludge was available.

Both sludges are described as being suitable for application by a conventional manure spreader. In addition during inclement weather the material can be stockpiled for later application to a field since it has stabilized. (ref. 4&10)

Although this product has a number of merits, its suitability for application in the North Bay area is questionable for the following reasons:

a) the relatively high collection costs associated with mechanical dewatering and lime stabilization;

b) the limited agricultural activity in the North Bay area; and

c) the long haulage distances required for agricultural disposal.

An area in Northeastern Ontario where its application might be more appropriate is the Little Clay Belt area of Timiskaming District where the extensive agricultural activity and consequent fertilizer demand may justify the higher collection costs. This system might also have considerable potential in other agricultural areas of the province.

3.4.2 Composting

Previous efforts to compost septage have encountered difficulties because of the low solids content of raw septage, approximately 2% (ref.1). The dewatering technique utilized in the Fossetic system increases the concentration of solids to 5.5-6.0% (ref. 7,8,&9). This material is much more amenable to composting.

The principal bulking material utilized is wood waste. The technique utilized is to discharge the dewatered septage to a filter bed consisting of wood waste and sand. The filters consist of approximately 60 cm of wood waste on top of 30 cm of sand material. The required ratio of wood waste to septage is approximately 3 or 4 to 1 (ref.7&8).

The filter has a capacity on average of receiving 0.04 cubic meters of septage per square meter per day. The filter is saturated after 3 cycles. The leachate from the filter is a fairly low strength sewage suitable for conventional treatment either by a tile bed or conventional lagoon (ref. 7&8).

Once the filter bed is saturated with septage it is deposited in piles by a front end loader. The material is then periodically turned using the front end loader to ensure maintenance of aerobic conditions. The mixing intervals are as follows:

- o every 15 days for the first three months; and

- o monthly for the balance of the first year.

The material is then allowed to mature under an opaque plastic cover for a further period of two years until it is ready for sale.

The resulting compost is an excellent growth media. Because of the high temperatures reached during the composting (60 C for the first ten days and 45 C for the following 8 to 10 months), all pathogenic viruses and bacteria are eradicated. The contents of the compost are summarized as follows:

Table VIII

Contents of Fossetic Compost (ref. 7)

pH	5.6
moisture content	120 %
Organic content	38 %
Unit Dry Mass	199 kg/m^3
Nitrogen	2.71 kg/tonne
Phosphorus	0.03 kg/tonne (see Note)
Potassium	0.2 kg/tonne
Calcium	1.67 kg/tonne
Magnesium	0.65 kg/tonne

Note: Phosphorus content would be considerably increased by alum precipitation.

The high organic content of the compost makes this an excellent soil conditioner. Although the nutrient content of the compost is relatively low compared to chemical fertilizers, it is available to vegetation over an extended period. In general this may regarded as an "environmentally friendly" soil additive.

The economics of the operation were described as follows for the summer of 1985. (ref. 7)

- o cost of treatment of septage \$8.36 per m^3 of septage collected
- o revenue from sale of compost \$3.36 per m^3 of septage collected
- o net cost of treatment \$5.00 per m^3 of septage collected

One particularly suitable and readily available source of wood waste is the digester sludge from the wood products plant operated by MacMillan Bloedel in Sturgeon Falls. The volume of production of this waste is estimated at 3750 cubic metres per year and it is currently landfilled. Based on a ratio of 3.5:1 of wood waste to septage this is sufficient to compost approximately 1000 cubic metres of septage annually.

Typical wood waste production at the Field Lumber Company in Field, Ontario is estimated at 40,000 cubic metres per year. Although much of this waste has a commercial market a residuum of bark and slashings is also available for composting although they may require mulching before being suitable for composting. Similarily other mills in the North Bay Area, have suitable waste materials available.

Another potential source of wood waste for composting is abandoned wood waste disposal sites which currently constitute a significant environmental concern in this area. Generally sufficient wood waste is available to supply a composting operation for a considerable period of time. Other nuisance vegetative materials such as the decayed plant matter washing up on the shores of Lake Nipissing could also be suitable composting materials.

Key technical questions remaining with this process include:

- o what are the heavy metal concentrations in the composted material?

- o what would be the impact of alum precipitated phosphorus sludge on the compost?
- o can municipal sludge be successfully composted given its typically higher heavy metal concentrations?

The major economic and soil concerns associated with application of this scheme in the North Bay area are as follows:

- o what markets are available for the compost? and
- o what are the costs of existing disposal practises and how can they be reflected in disposal charges?

The last question is particularly relevant as no charge is levied for discharge of septage to the North Bay Sewage Treatment Plant at this time despite a considerable load on plant facilities.

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LESSONS FROM ENVIRONMENTAL EMERGENCIES

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"LESSONS FROM ENVIRONMENTAL EMERGENCIES"

E. W. Piche

Air Resources Branch

Ministry of the Environment

OCTOBER 17, 1990.

1. INTRODUCTION

The Ministry of the Environment for the Province of Ontario has the mandate to preserve and protect the Environment. The Air Resources Branch, of the Ministry is, as the name suggests, responsible for the air component of Ontario's environment. This presentation will briefly outline the responsibilities of the Ministry and the Air Branch, highlight some of the state-of-the-art technology of the Branch and outline in detail the experience gained in the past decade in dealing with environmental "air" emergencies.

2. ROLES

2.1 ROLE OF THE MINISTRY OF THE ENVIRONMENT

The Ministry of the Environment is responsible for achieving and maintaining a quality of the environment, including air, water, and the land, that will protect human health and the ecosystem and will contribute to the well-being of the people of Ontario. In protecting life, property and the environment during emergencies and spills, the plans and actions of the Ministry of the Environment are subordinate to those plans and actions of other front line agencies, i.e. Fire departments, Police and Military units.

2.2 ROLE OF THE AIR RESOURCES BRANCH

There are five Divisions within the Ministry of the Environment. The Air Resources Branch is one of Four Branches of the Environmental Services Division. Within the Environmental Services Division, the Air Resources Branch is responsible for providing scientific and technical services, and for developing programs dealing with air resources for the protection of the ecosystem and human health. The Air Resources Branch, as a required by this responsibility, has developed over the last decade an incident response capability second to none in the world.

3. ORGANIZATION OF THE AIR RESOURCES BRANCH

3.1 SERVICE ORIENTATION

The Air Resources Branch is a service oriented Branch, with the goal of maintaining state-of-the scientific and technical knowledge in order to best protect the people and the environment of Ontario.

The Branch consists of five major groups: Program Coordination, Emissions Technology and Regulation Development, Air Quality and Meteorology, Atmospheric Research and Special Programs and Phytotoxicology. Each group has specialized expertise which when combined during an incident and the follow thereafter is essential to the success of our response capability.

3.2 PROGRAM COORDINATION

Program Coordination does exactly as the name implies. When the Branch is notified of an incident, then it is the responsibility of the Coordination group to ensure that all necessary support is available and deployed as appropriate. This requires being aware of the status of all employees, i.e. on holidays, sick leave, secondment or training and development, and then planning schedules and deploying as appropriate. This activity must be coordinated with other Branches within the Ministry, with other Ministries within the Government and/or other Governments within the country, including Municipal, Provincial and Federal. Finally, since the notification is usually through the Spills Action Centre Office, it is important, at least in the early stages, to keep that Office up to date on incident related activities.

3.3 EMISSIONS TECHNOLOGY AND REGULATION DEVELOPMENT

The ETRD Section has relevant experience in the applied sciences including process engineering and control, standards development and knowledge of the behaviour of materials and substances under "normal" as well as the adverse and unusual circumstances that often accompany emergencies.

3.4 AIR QUALITY AND METEOROLOGY

The AQM Section maintains full time, 24 hours per day, 365 days per year, ambient air monitoring stations with over 100 instruments in more than thirty five Ontario Cities. Pollutants monitored include: Total Suspended Particulates, Sulphur Dioxide, Oxides of Nitrogen reported as Nitrogen Dioxide equivalent, Carbon Monoxide, Total Reduced Sulphur and Ozone as well as local meteorological/weather conditions. In addition state-of-the-art "real time" modelling capability, together with site specific weather, is likewise available around the clock 365 days a year.

In an emergency situation wether it be radioactive emissions or releases of toxic materials like chlorine or polychlorinated biphenols (PCB's), into the air, weather and modelling site specific information are of critical importance in scoping the appropriate management response. The prevailing weather conditions and forecast; wind speed and direction, front characteristics such as stability and precipitation type, quantity and duration, all strongly influence the "area at risk" that is the total area which could be impacted by the emissions at some time during the emergency. Timely meteorological and modelling advise is therefor critical at an early stage of the incident in order to provide the best protection for the citizens at the site. It is also very useful when attempting to determine where significant quantities of the incident related materials may have been deposited in order to assist clean up after the incident.

3.5 ATMOSPHERIC RESEARCH AND SPECIAL PROGRAMS

The ARSP Section maintains a full arsenal of the most advanced equipment in the world in order to respond to environmental emergencies. Currently the foremost instrument in this arsenal is the mobile monitor known as the TAGA 6000, (Trace Atmospheric Gas Analyzer). This instrument is mounted in a large bus like vehicle and is able to move very quickly to the disaster site as well as being very mobile when in the vicinity of an emergency. Current the TAGA 6000 has a library which contains the identifying characteristics for more than 700 compounds. In most instances these compounds can be detected in "real time" at concentrations of the order of parts per billion once the vehicle is on site and calibrated. Most preliminary screening measurements can be completed in one minute, thus allowing the rapid detection of life or property threatening substances.

This vehicle can track a wide rang of organic and inorganic compounds including ammonia, chlorine, hydrochloric acid, polychlorinated biphenyls (PCBs), and chlorinated and aromatic hydrocarbons. A five-foot glass tube on the roof of the vehicle provides a pathway for ambient air to be drawn into the inlet of the TAGA 6000. Inside what looks like a four foot stainless steel drum, the inlet air/gases are immediately ionized in a low pressure chamber. After passing through additional instrument steps, the various ions leave unique traces which with the aid of sophisticated computer processing methods identifies the substances associated with the incident.

On site, this vehicle and its' predecessor, the TAGA 3000 have proven their worth many times when challenged. Specific high profile incidents include:

- The Mississauga train derailment fire and evacuation in November of 1979 (TAGA 3000)

- The Medonte train derailment and fire, in February of 1983 (TAGA 3000)

- The Saint Basile le Grande fire and evacuation in October of 1988 (TAGA 6000)

- The Hagersville tire fire and evacuation in February of 1990 (TAGA 6000).

These vehicles which determine the location and strength of the toxic plume, also provide on site weather information, (such as wind speed and direction, precipitation quantity and kind and so on), for the AQM modellers who as we indicated earlier, provide information critical to the decision makers.

3.6 PHYTOTOXICOLOGY

After the incident has been brought under control and life has returned to some semblance of "normal", members of the Phytotoxicology Section design environmental sampling and monitoring programs to determine what impact, if any, the incident will have on the environment and what remedies might be employed to alleviate or otherwise minimize the short and long term effects.

This activity involves selecting and analyzing large numbers of samples of site soils and vegetation.

In some instances special experiments may need to be undertaken in controlled circumstances in order that the scientists involved have a better understanding of what may have occurred as well as what to expect. The scientists and technicians of this Section have the equipment and experience to undertake and or support such studies.

4.0 LESSONS

The Air Resources Branch has been involved as a participating agency in environmental incidents for over ten years. During that time a great deal has been learned with respect to what and what not to do. While some of the lessons were quite difficult, and some of the knowledge gained is nothing more than not-so-common "common sense" all merit stating at this time:

1. Organizational structure and incident chain of command must all be in place prior to the incident.

2. A senior on-site coordinator is absolutely essential for success. Further, all on site personnel must know who is in charge at all times. It goes without mentioning that it is essential that incident response personnel have absolute confidence in the capability of their colleagues and the integrity of their equipment.

3. Communication protocols must be defined before the incident and strictly adhered to once at the site.

4. All scientific procedures must be formulated and approved by scientific experts before hand. This of course means that all staff must be appropriately selected and trained.

5. Mobility and on-site measurements are essential to provide the kind of protection and assurances necessary to remain in control. The importance of on site visibility of the response team and their equipment cannot be overemphasized. This presence, helps to calm those whose lives or property is in danger.

6. An effective incidence response capability is very expensive as equipment and staff must be ready at all times. Currently it costs from ten to fifteen thousand dollars per day per machine for this capability. However as experience has shown, this is very a very modest sum when considered with respect to the benefits when the need arises.

5. FUTURE

5.1 SHORT TERM

In the immediate future we will expand our on-site capacity and capability by:

1. Purchasing an additional TAGA 6000,

2. Improving our ability to analyze "grab samples " on site, that is the ability to take cartridge samples by hand remote from the vehicles and return them to the vehicles for immediate analyses,

3. Adding many additional chemical fingerprints to the library of compounds,

5.2 LONGER TERM

The longer term will see the advent of additional automation and further complexity of procedures as we constantly improve our detection levels. In the more distant future significant reductions in the size of the equipment is well within the realm of possibility.
This will allow for a quicker response time over a much broader geographical area of the Province.

LESSONS FROM
ENVIRONMENTAL EMERGENCIES

AIR RESOURCES BRANCH
MINISTRY OF THE ENVIRONMENT

OCTOBER 17, 1990
Sault Ste. Marie, Ontario

INTRODUCTION

- MINISTRY MANDATE
- ARB MANDATE
- STATE-OF-THE-ART
- LESSONS

ENVIRONMENT ONTARIO
MANDATE

THE MINISTRY IS RESPONSIBLE FOR ACHIEVING AND MAINTAINING A QUALITY OF THE ENVIRONMENT, INCLUDING AIR, WATER, AND LAND, THAT WILL PROTECT HUMAN HEALTH AND THE ECOSYSTEM AND WILL CONTRIBUTE TO THE WELL-BEING OF THE PEOPLE OF ONTARIO.

AIR RESOURCES BRANCH MANDATE

WITHIN THE ENVIRONMENTAL SERVICES DIVISION, THE AIR RESOURCES BRANCH IS RESPONSIBLE FOR PROVIDING SCIENTIFIC AND TECHNICAL SERVICES, AND FOR DEVELOPING PROGRAMS DEALING WITH AIR RESOURCES FOR THE PROTECTION OF THE ECOSYSTEM AND HUMAN HEALTH.

AIR RESOURCES BRANCH ORGANIZATION

- PC
- ETRD
- AQM
- ARSP
- PHYTO

PROGRAM COORDINATION

MANAGES OVERALL BRANCH RESPONSE

COORDINATES RESOURCE DEPLOYMENT

LIAISES WITH SAC

EMISSIONS TECHNOLOGY AND REGULATIONS DEVELOPMENT

PROCESS CONTROL

MATERIALS BEHAVIOR

ENGINEERING PRACTICES

AIR QUALITY AND METEOROLOGY

BACKGROUND DATA

METEOROLOGY

MODELLING

ATMOSPHERIC RESEARCH AND SPECIAL PROGRAMS

TAGA'S

ON SITE WEATHER

HIGH PROFILE INCIDENTS

PHYTOTOXICOLOGY

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- COMMAND CHAIN
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- COMMUNICATIONS
- BEST SCIENCE
- MOBILITY
- EXPENSIVE

FUTURE

NEW TAGA

GRAB SAMPLES

MORE COMPOUNDS

DOWNSIZING

TRIHALOMETHANE IN DRINKING WATER TREATMENT

Francois Fiessinger
Zenon Environmental
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INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE
SAULT SAINTE MARIE, ONTARIO
OCTOBER 15-17, 1990

TRIHALOMETHANES IN DRINKING WATER TREATMENT : ALTERNATIVE METHODS FOR DISINFECTION

François Fiessinger
Zenon Environmental Inc.

INTRODUCTION

Disinfection is a unit process whose objective is the destruction or otherwise inactivation of pathogenic microorganisms, including bacteria, amoebic cysts, algae, spores and virus.

Alternative disinfection systems available for disinfection are numerous. Generally, they can be divided into two groups: (1) chemical agents and (2) non chemical agents. Chemical agents include an array of compounds with oxidation potential including chlorine, chlorine dioxide, bromine, iodine and ozone. Non chemical or energy related means of disinfection include ultra violet (UV) radiation and gamma radiation. Among these, chlorine is by far the most important one.

Since its introduction into water treatment in the beginning of this century, chlorine has held a predominant position as reliable disinfectant because of its broad range biocidal effectiveness, its reasonable persistence in treated waters, its ease of application and control and its cost effectiveness. In addition chlorine is the only chemical agent that is able to oxidize ammonia readily. Chlorine is also used for controlling the proliferation of algae during the warm periods in uncovered coagulation and sedimentation basins. Unfortunately, when organic matter is present chlorination results in the formation of undesirable halogenated compounds; i.e. total halogenated compounds (TOX) and more particularly the trihalomethanes (THMs).

The present paper is a general review of what are the THMs and more particularly of how they can be reduced by a better adjustment of current water treatment practices. A major part of the paper comes by a previous presentation made by the author in 1985: F. Fiessinger, J.J. Rook and J.P. Duguet, Alternative Methods for Chlorination, The Science of the Total Environment 47 (1985) 299-315. Alsevier Science, Amsterdam.

THE TRIHALOMETHANES

THMs are a class of organic compounds produced during chlorination of water. They include trichloromethane (chloroform), bromodichloromethane, dibromochloromethane, and tribromomethane (bromoform). The distribution of THM species depends upon the concentration of bromide in the water. The US EPA has set a drinking water maximum contaminant level (MCL) of 100 ug/L for the total THMs (TTHMs) which is the sum of these four haloform compounds. The EEC regulation is similar, but the Canadian standards are still at a level of 300 ug/L.

During the course of drinking water treatment, a reaction occurs between free chlorine and certain types of organic contaminants forming trihalomethanes.

Free chlorine + Precursors ---> THMs + other disinfection by-products (DBPs)

The primary precursors of THMs are natural humic substances measured as total organic carbon (TOC). Other precursors include algal cells, methyl ketones (such as acetone), and dihydroxybenzenes (such as resorcinol). Humic materials have been demonstrated to be the predominant precursors of THMs in most natural waters. They are present at higher concentrations than other precursors, and they react with chlorine more rapidly under normal water treatment conditions. In reservoir waters, algal cells and algal cell by-products are also THM precursors.

The variables that affect THM formation are:

1. Temperature: Seasonal variations in temperature will influence THM formation. In general, greater THM formation occurs with increasing temperature.

2. pH: In general, an increase in THM formation is found at higher pH.

3. Bromide concentration: Bromide and iodide ions are oxidized by aqueous chlorine to species capable of forming brominated and/or iodated THMs. Iodated THMs are not included in the total THMs, however, iodated THMs cause medicinal tastes and odors in drinking water.

4. Precursor type and concentration: Recent research suggests that THM formation is highly dependent upon the applied chlorine concentration and consequently upon the chlorine to carbon ratio.

6. Reaction time: THM formation increases with increasing reaction time until reaching a certain maximum. Reaction time is related to the time in the water distribution system. The factors 1-5 as described above affect the reaction rate.

There are many predictive models for estimating/calculating THM formation but each model applies only to a specific water containing specific precursor (e.g. humic material) in that water. The appropriate parameters for every water need to be determined on a site specific case-by-case basis. Thus, each water treatment site is unique and must be studied separately.

The use of modern analytical techniques has lead to the identification of a large part of the THM as illustrated in Table 1, Table 2 and Figure 1. Some of these compounds like dichloroacetonitrile, several chlorinated ketones, chloroform are known to be mutagenic or toxic.

The effects of water chlorination on mutagenic activity have been studies. Many authors conclude that chlorination increases mutagenicity (Fig. 2) but the nature of organics and chlorination conditions have a great influence. Thus it is often found that during chlorination of treated water, variation of mutagenicity along the year is not statistically significant.

Numerous studies have been undertaken to gather and evaluate the epidemiology and toxicology data with respect to potential adverse health effects in animals and humans from chronic low level ingestion of THMs and DBPs. They also attempt to provide human cancer risk estimates and suggested no-adverse-effects levels (SNARLS) of selected disinfectants and their by-products. Their results are somewhat controversial, but many concluded that the current 100 ug/liter THM standard is insufforable and should be lowered. It is thus expected that the standards for THM levels in drinking water, will lower in the coming years.

Finally, another risk is related to the direct toxicity of chlorine gas during its road transport and its storage as liquid chlorine, in plants located near densely populated areas. This risk can be avoided by using sodium hypochlorite instead of liquid chlorine, though at a 20 to 25% increase in costs. In situ generation of chlorine, through electrolysis might also be applied.

ALTERNATIVE DISINFECTANTS

Although chlorine is a good disinfectant, the potential health risks of halogenated by-products formation have caused the entire subject of drinking water disinfection to be reconsidered. The main alternative disinfectants in use are ozone, chlorine dioxide, chloramines and to a less extend ultraviolet light, hydrogen peroxide, permanganate, other halogens and silver ions. An extended summary of oxidant properties based on these surveys shown in Table 3.

For the evaluation of the different properties and effects of an alternative disinfectant it must be distinguished where it is applied in the treatment process, either in preoxidation as an intermediate step or in post-disinfection, i.e. before or after the bulk of the organic matter, especially the trihalomethane formation potential (THMFP) has been removed.

Table 3: Comparison of Various Disinfectants

	Cl_2	ClO_2	O_3	$KMnO_4$	NH_2Cl	H_2O_2
Iron and maganese	+	++	+++	+	-	+
Ammonia	+++	-	-	-	-	-
THM formation	+++	-	-	-	-	-
THM precursors removal		+	++	+	-	-
Formation of mutagens	+	+-	+-	-	?	?
or toxic substances	+	+-	+-	-	?	
Enhanced biodegradability	+	++	++	+	-	?
Taste removal	-	+	++	+	-	+
Disinfection	+	++	+++	+-	+-	+

- no effect ++ effect
+ litte effect +++ very effective

Preoxidation

Traditionally preoxidation is performed at the beginning of the treatment process to ensure good hygienic conditions throughout the treatment and to control algal growth in flocculation basins. Thus growth can be limited by covering the basins provided that ammonia would be removed in subsequent treatment steps.

Permanganate

The application of permanganate in pretreatment oxidizes iron, manganese and destroys taste and odor causing substances. It can reduce THMFP but at the pretreatment dosage usually applied the reduction of chloroform formation is relatively modest. Permanganate is not a very effective disinfectant and a possible residual of manganese precipitation in the distribution system are two reasons why permanganate is rarely used in water treatment.

Chlorine dioxide

The great advantages of the use of chlorine dioxide in pretreatment are algicidal effect and negligible formation of halogenated by-products. However, chlorine dioxide produces polar compounds such as aldehydes, ketones and acids. The main inorganic by-products is chlorite which is reported to be toxic.

Using mouse skin initiation promotion assays, among mice when concentrates of water disinfected with chlorine dioxide were applied, no effect was observed. However, short term toxicity of chlorine dioxide and more specifically its inorganic reaction products may present a higher risk than chlorine or ozone.

Chloride ($Cl0_2$) and chlorate ($Cl0_3$) in high concentrations (100 mg/l) have been found to produce methemoglobinemia in animals. These uncertainties have made health authorities reluctant to allow the application of chlorine dioxide in many countries. In some countries standards as low as 0.1 mg/l chorites have been edicted. In order to maintain these inorganic by-products at such a low level, the reagents and the by-products concentrations have to be constantly monitored which cause. Many analytical problems are not yet solved. The disinfective efficiency of chlorine dioxide is reported to be superior to that of chlorine. On the other hand when $Cl0_2$ is applied in open basins the photodecomposition of $Cl0_2$ necessitates the application of an excessive dose (Fig. 3). The costs for applying chlorine dioxide are 3 to 4 times higher than those for chlorine.

Ozone

The preozonation of natural organic matter does not lead to its direct removal as is reflected by nearly unchanged TOC values. The primary effect is to modify the chemical nature of the molecules towards increase of polarity. The increased polarity will in turn favor adsorbability in subsequent coagulation filtration and adsorption processes. A clear example of improved turbidity removal induced by oxidative pretreatment was found for preozonated Seine water (Fig. 4). The same improvement however, could be achieved by a slightly increased alum dose, such that in this case preozonation was an expensive means for saving on flocculent costs.

It has been shown that preozonation of certain lake waters reduced the formation potentials of THM and TOX significantly (Fig. 5). Doses exceeding 1.2 mg 03 per mg TOC per liter hampered the removal of THM and TOX precursors in alum coagulation. It has also been reported that improved removal of turbidity caused by humic acid coated mineral particles along with improved particle agglomeration, when preozonation was applied in ratio's below 0.8 mg 03 per mg TOC. Increase of that ratio had no further effect.

The polymerizing effect of ozone on small sized micropollutants may present more interesting possibilities. It has been found that ozonation induced polymerization to hexamers and insoluble polymers, which will improve removal in coagulation filtration.

As with other oxidants, ozonation also leads to formation of organic by-products mostly aldehydes, ketones and carboxylic acids. Especially aldehydes have been quantified.

Ozonation by-products may also induce mutagenicity in the treated water which can be effectively removed by activated carbon. It is also possible to diminish the production of mutagens during ozonation by prolonged contact time or dosage (Fig. 6). Ozonation of organic matter will naturally increase biodegradability, which can be considered (Fig. 7) as an advantage as well as a disadvantage. This material must be removed biologically before the water leaves the treatment plant

since it may interfere with post disinfection. A principle disadvantage of the biodegradation taking place in biologically operated carbon filters is that a complete ecology of higher plankton will develop and foul the filters. Practical experience has shown that the filtered waters may contain heavy loads of zooplankton during summer periods.

In our view the full advantage of preoxidation can only be obtained when used in combination with an effective means of removing biodegradable substances, such as slow sand filtration. As an example, preozonated slow sand filters remove 30 to 35% of the initial 3.0 to 4.0 mg/l TOC versus 15% in the non-ozonated control filter.

Post Disinfection

The reason for the use of disinfectants after the complete water treatment is to kill or inactivate microorganisms still present to protect the distribution system from regrowth and safeguard hygienic quality. This necessity is even more pronounced if prechlorination is abandoned. In this case post-disinfection may be the only hygienic barrier. The choice of disinfectant must be made on the basis of germicidal activity and persistence for maintaining a residual in the network to prevent any further contamination. Experimental data show the following order of decreasing germicidal efficiency 0_3>$C10_2$>HOCl>OCl>$NHCl_2$>NH_2Cl. Ozone is the best disinfectant but its half life is not sufficient to maintain a residual (Fig. 8). However the application of ozone may produce some biodegradable matter resulting in regrowth.

For chlorine dioxide this problem exists to a less extent. Besides it has the advantage of its long half life ensuring a residual throughout the network. At the final point of the treatment organic matter is at minimum. The formation of chlorite by the organic matter reduction of $C10_2$ is than limited such that the acute toxicity may be considered to be less significant.

Some combinations of oxidants like chloramine + hydrogen peroxide have been shown to improve control of bacterial regrowth in a treated surface water for which chlorine disinfection was insufficient. More studies should be done to verify the efficiencies of such combinations (H_20, 0_3 + H_20_2 +UV, 0_3 +UV). Disinfection using UV involves different mechanisms such as direct UV action and formation of high energetic radicals which have short half lifes, but the problem of persistence remains. This short survey shows that replacement of chlorine by another disinfectant is not quite an easy task. The ideal disinfectant may have four main properties:

- germicidal effect
- persistent residual
- no precursor or toxic by-products
- low cost.

Chlorine still remains the best available means of disinfection. However optimal conditions for its application must be determined with respect to a minimizing by-product formation to ensure hygienic safeguard. It is still preferable to reduce the ammonia content by biological treatment in order to avoid high chlorine demands.

ALTERNATIVE STRATEGIES FOR A BETTER USE OF CHLORINE

With the objective to reduce halogenated compounds such as THMs, two treatment strategies can be followed: the chloramination and the use of chlorine after a maximal reduction of organics and specifically mainly the precursors of chlorinated compounds. The development of new adsorbents such as activated alumina and resins may further improve the removal or precursors. The emergence of membrane separation which not only removes a large portion of the precursors but also the germs is also full of promises. Specific nano filtration membranes designed for the removal of THMFPs (more particularly humic substances responsible for colour) are now being installed in Florida and are applied at pilot plant levels in several locations in Canada.

Chloramination

As illustrated in figure 9 in natural water containing ammonia, the trihalomethanes are formed at a chlorine dose corresponding to the destruction of chloramines of free appearance of free chlorine.

Although the chloramines are weak disinfectants they have algal inhibiting properties. With the objective to reduce halogenated compounds, the pretreatment may be realized with chloramines. In this case, the chlorine dose must be adjusted to the maximum of chloramine with or without addition of ammonia. On line measurement of chloramines is not easy and the process control is difficult to realize.

The main problems related to chloramines are tastes and odors and some health effects. Although monochloramine is the predominant form at a pH of 8, the correlated traces of di an trichloramines have offensive odors as shown in Table 4.

Table 4: Sensory Threshold Values (from: Krasner 1984)

Compounds	Threshold Aroma	(mg/l as C12 Flavor
Hypochlorous acid	0.28	0.24
Hypochlorite ion	0.36	0.30
Monochloramine	0.65	0.48
Dichloramine	0.15	0.13

The health effects of chloramines and the knowledge of by-products formed (organic chloramines ...) need more research, thus chloramines have recently been found to cause hemolytic anemia in patients undergoing kidney dialysis. To solve the problems of taste, odors and health effects chloramination may be followed by a chloramine removal from water by reduction on activated carbon which should be carefully monitored to produce a water of desired quality. This alternative chlorination is now being offered on some of the largest water utilities in the USA.

OPTIMIZATION OF ORGANICS REMOVAL BEFORE CHLORINATION

As illustrated by Figure 10 the use of chlorine only at the end of the water treatment permits a great reduction of THM formation. A low THM level may be obtained by the optimization of each treatment step. Coagulants such as A13+ and Fe3+ remove significant concentrations of TOC and THM precursors which, in actual practice tends to range from about 40% to 70%. Usually the removals of THMF concentrations tend to be higher than the corresponding reduction in TOC. Some improvements in the utilization of metal coagulants can result in a better reduction of precursors but the combination of ozone with an adsorbent like activated carbon can retain a large part of organics from clarified water. This unit operation is already used routinely in drinking water production in Europe. However, activated carbon is a rather non specific adsorbent which while a good principle, frequently leaves a fraction of organics in the water which may give rise to halogenated compounds during post-chlorination. Improvements of the yield of the adsorption will be feasible by use of new adsorbents of different nature combined with an optimized oxidation like e.g. ozone coupled with hydrogen peroxide (Fig. 11). Ozonation in all cases produces polar products which are less adsorbable by activated carbon. This is illustrated by shifts in the adsorption isotherms shown in Figure 12. It is reported that the K-value of the Freundlich isotherm (TOC) was diminished by a factor 3 after preozonation. With activated alumina, however, an increased adsorption was observed, enhanced by the combined action of 0_3 and H_20_2. This case is an example of an optimization of organics removal which can lead to more effective reduction of the formation of toxic compounds during final chlorination.

Again, membrane separation through specific nano filtration membranes seems to be the best emerging technology and it is likely that many smaller plants will be equipped with membranes in the coming years. US EPA, in fact is not far from considering membranes as the best available technology (BAT) for DBPs control, particularly if levels are further lowered.

An additional advantage of having removed organic matter as far as possible is the reduction of chlorine consumption in the distribution system resulting in lower doses needed for maintaining a desired residual. Depending on the state of network multiple injections of low doses of chlorine at several crucial points may be necessary.

CONCLUSION

It seems likely that, driven in particular by the US EPA, the water quality standards on THMs and DBPs will be further lowered. It is not sure when and to what extent however. The general economic situations of the concerned countries will be a determining factor, since the cost of providing such a good quality water will be high. It appears clearly however, that the regulations will be more and more driven by a growing public demand - a quest - for quality than by a government push.

The levels might be lowered to 30 ug/l THM. In this light new technologies such as membrane separation, aimed at removing the precursors will quickly develop.

Again and finally, there is no satisfactory alternative for chlorination and the only way in the long term to resolve the problem is to better remove the organic substances.

Humic acid
Fulvic acid
Lignin

Amino acids
- methionine
- phenylalanine
- tyrosine
- tryptophan
- histidine
- proline
- hydroxproline
- cysteine
- cystine
- glycine

Proteins:peptides
- albumin
- glycyl-phenylalanine
- phenylalanyl-glycine

acetovanillone
acetoveratrone
m-hydroxyacetophenone
p-hydroxyacetophenone
m-methoxyacetophenone
p-methoxyacetophenone

phenol
catechol
resorcinol
3-methylcatechol
4-methylphenol
hydroquinone
phloroglucinol
pyrogallol
guaiacol
veratrol
p-hydroxybenzoic acid
3,4-dihydroxybenzoic acid
ferulic acid
o-vanillic acid
p-vanillic acid
eugenol
fumaric acid
muconic acid
4-phenylphenol
2,4,6-trichlorophenol
4,5-dichlorophenol
2,5-dichloro-p-benzoquinone
2,6-dichloro-p-benzoquinone
mesityloxide
isophorone

TABLE 1 : Precursors of mutagenicity after chlorination

bromoform	A
bromochloromethane	A
bromodichloromethane	A,D
dibromomethane	A,D
dibromochloromethane	A,D
bromomethane	A
1,2-dichloroethane	A
iodoethane	A
1-bromopropane	A
1-bromobutane	A
trichloroethylene	D
tetrachloroethylene	D
tetrachloropropene	D
pentachloropropene	D
1,3-dichloropropanone	B,D
1,1-dichloropropanone	A,B
1,1,1-trichloropropanone	A,B
1,1,3-trichloropropanone	B
1,1,3,3-tetrachloropropanone	B,D
hexachloropropanone	D
3,5,trichloropent-4-ene-2-one	D
chloral	
chloroacetaldehyde	D
2-chloropropenal	B,D
3,3-dichloropropenal	B
2,3,3-trichloropropenal	B
2-phenyl-2,2-dichloroethanal(PCDE)	C
chloropicrin	A
bromochloroacetonitrile	A
dichloroacetonitrile	A,B,C
trichloro-1,2,3-trihydroxybenzene	D
bromo-p-cymene	D
dichloro-p-cymene	D
E2-chloro-3-(dichloromethyl)-4-oxo-butenoic acid(E-MX)	A,B,C,D
3-chloro-4-(dichloromethyl)-5-hydroxy-2 (5H)-furanone (MX)	A,B,C,D
3,4-dichloro-5-(dichloromethyl)-5-hydroxyfuranone	D

TABLE 2 : Bacterial mutagens produced by aqueous chlorination
A: chlorinated drinking water *B: chlorinated humic substances*
C: chlorinated amino acids *D: chlorinated wood pulp*

Figure 1

Pie Diagram For Molecular Weight of TOX distribution after Prechlorination of a Reservoir water (Cholet,France) and speciation of the volatile fraction

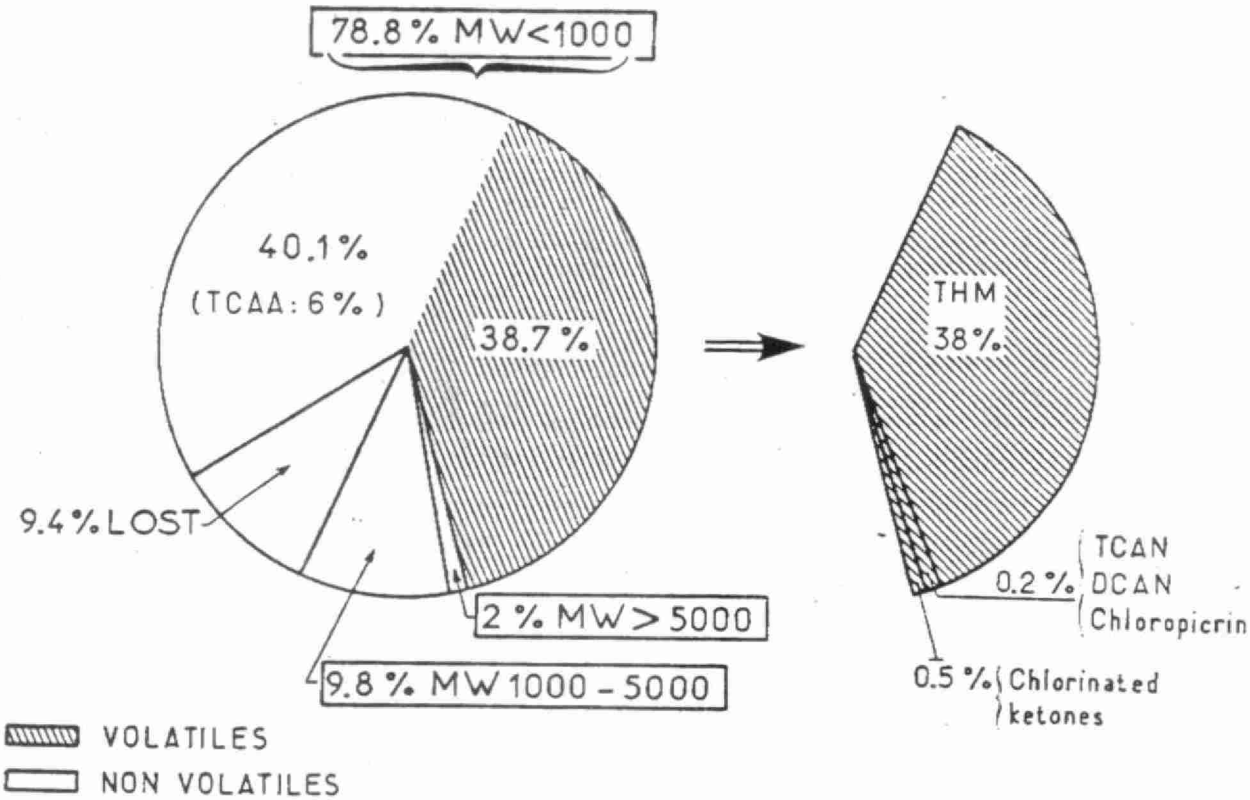


Figure 2

Comparizon of mutagenic activity in Salmonella Thyphimurium strain TA 98-S9 before (X) and after prechlorination/dissolved air flotation (▲) of a surface water (Moulle,France)

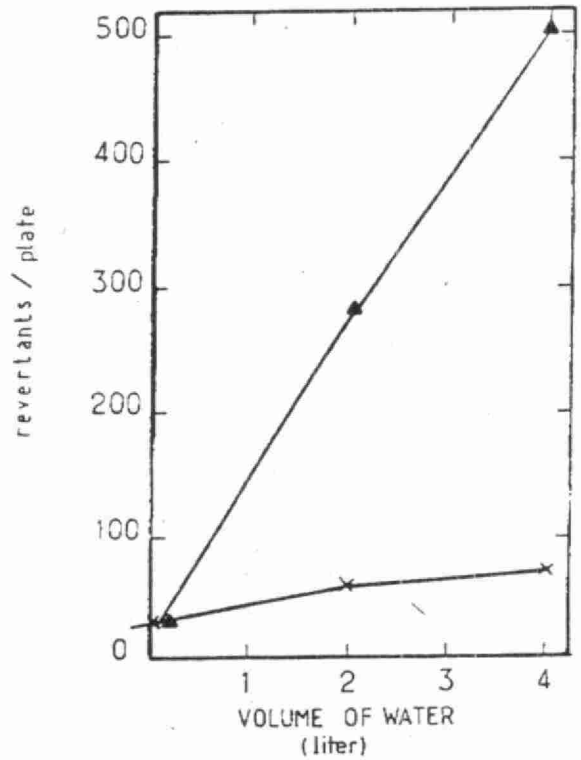
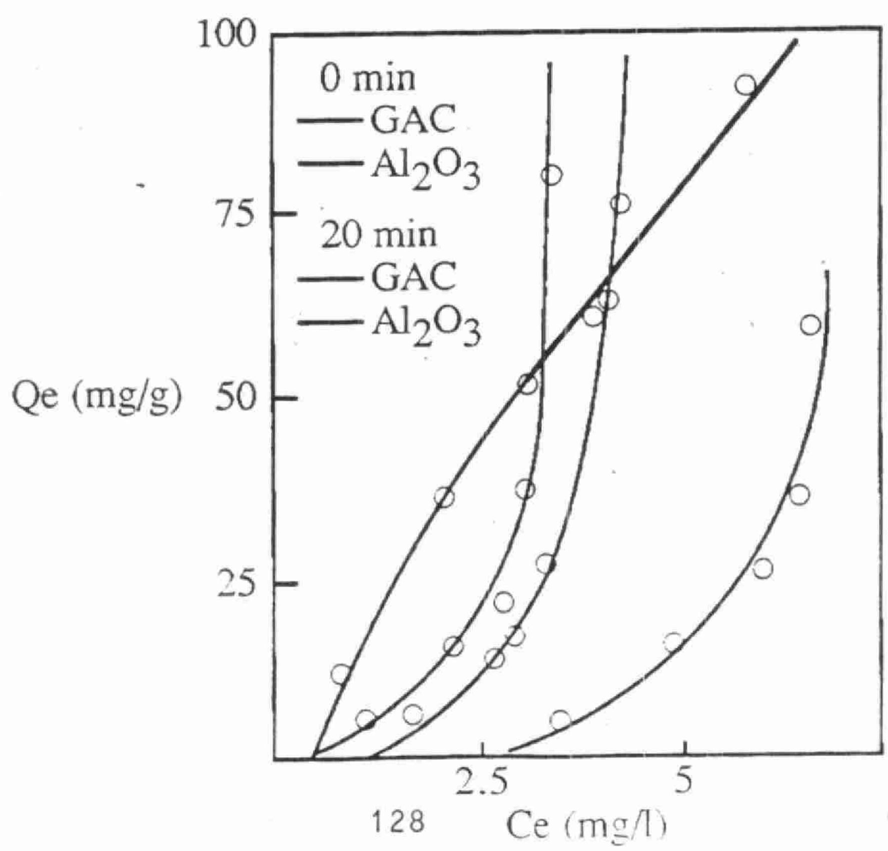


Fig. 12. Effect of ozonation on the isotherms for adsorption of a lake water (Cholet) on alumina and activated carbon.



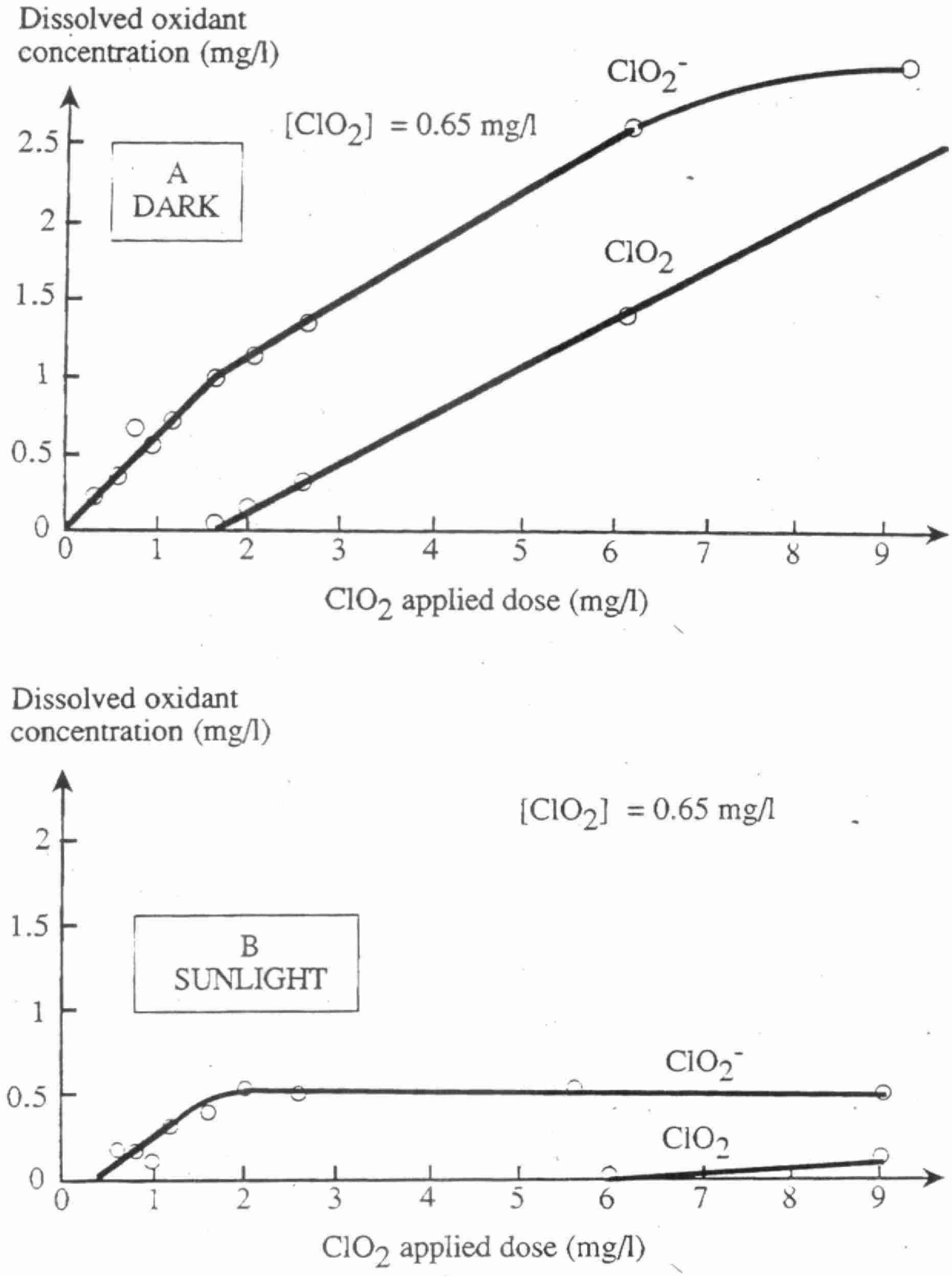


Fig. 3. Possible positions of oxidation treatments in surface water treatment process.

(Croissy, France)

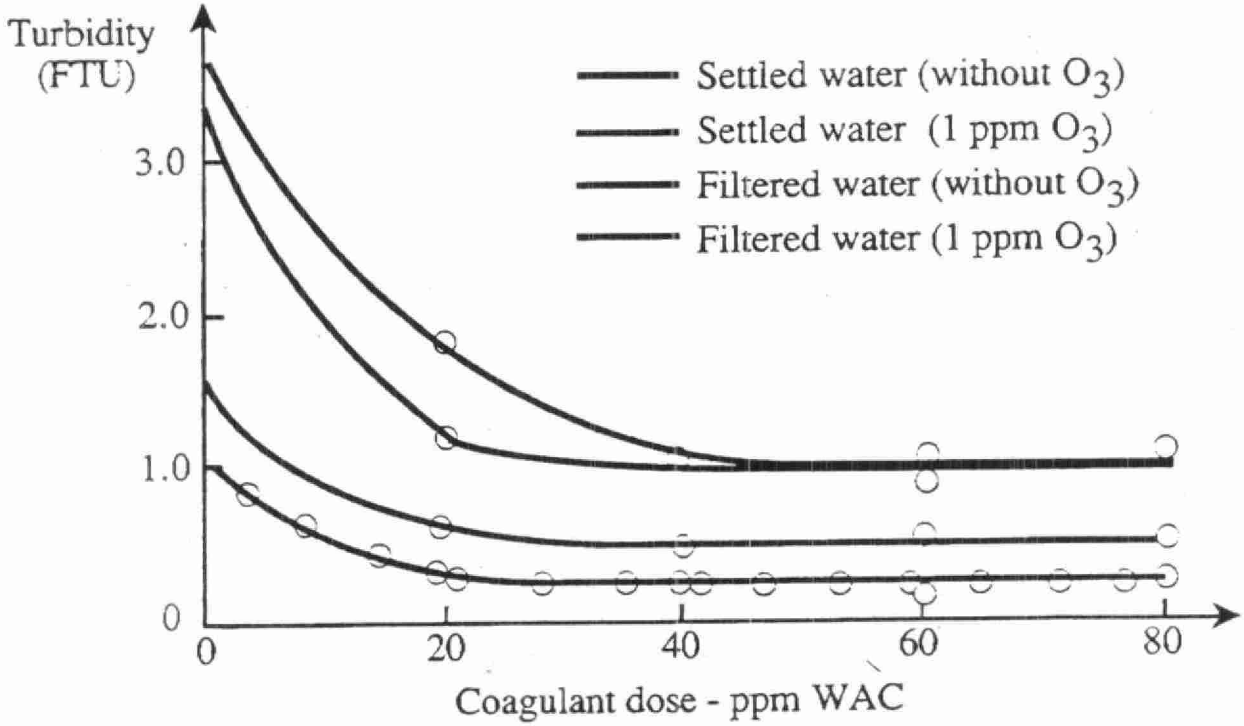
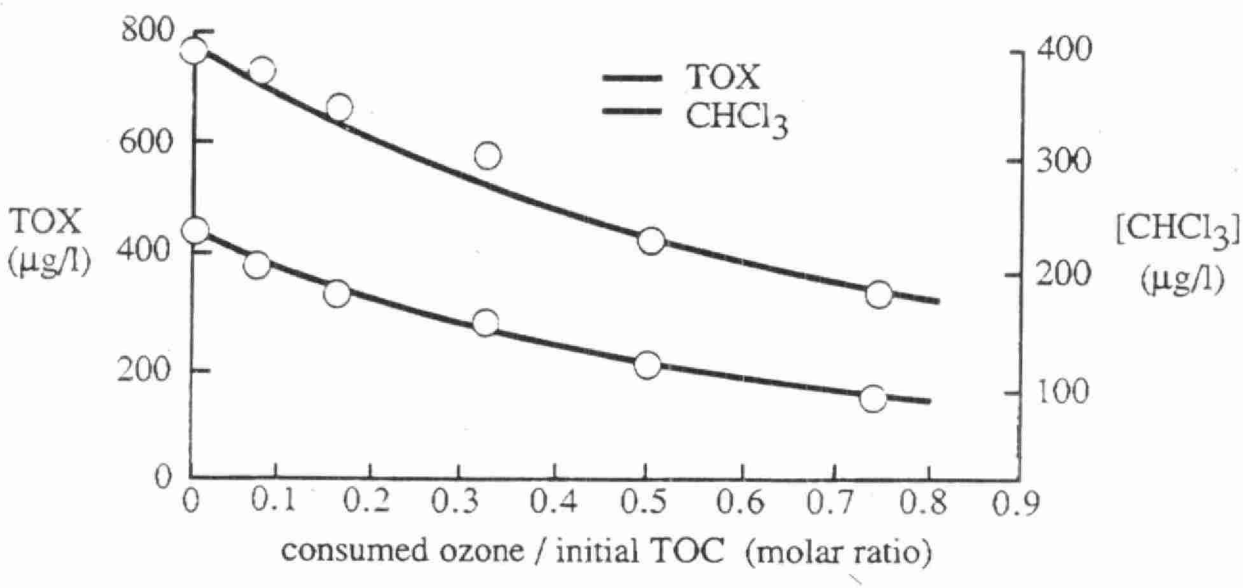


Fig. 5. Effect of preozonation on TOX and CHCl3 formations during subsequent chlorination of black lake fulvic acid (from Reckow, Singer, 1984)



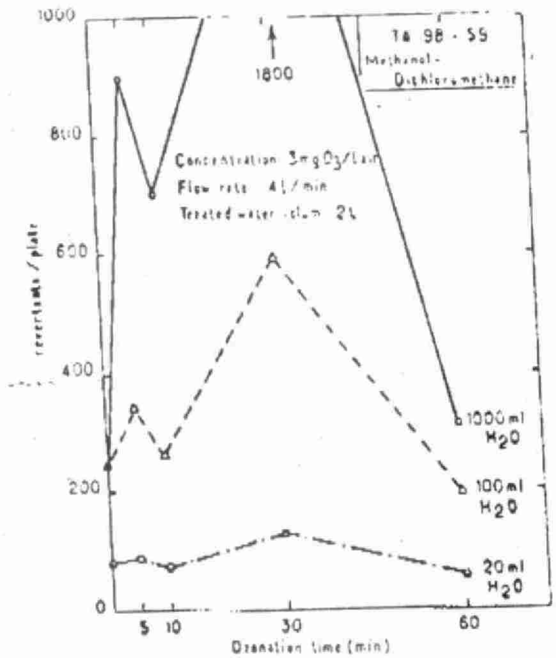


Fig. 6 Effect of ozonation conditions on mutagenic activity of a ground water at three sample volumes (Le Pecq, France)

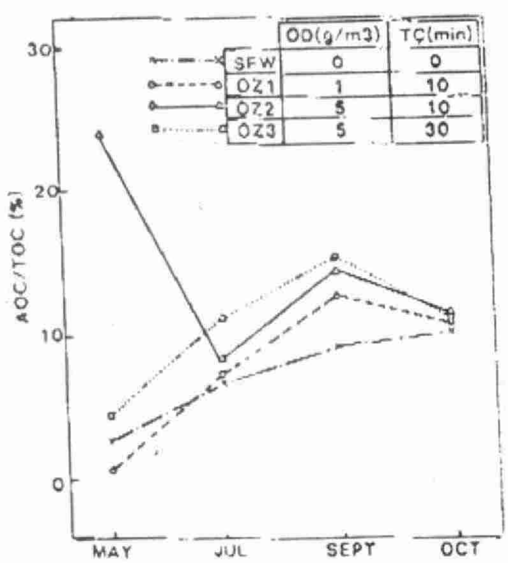


Fig. 7 Effects of ozone dose (OD) and contact time (TC) on the biodegradability of a filtered water (SFW)

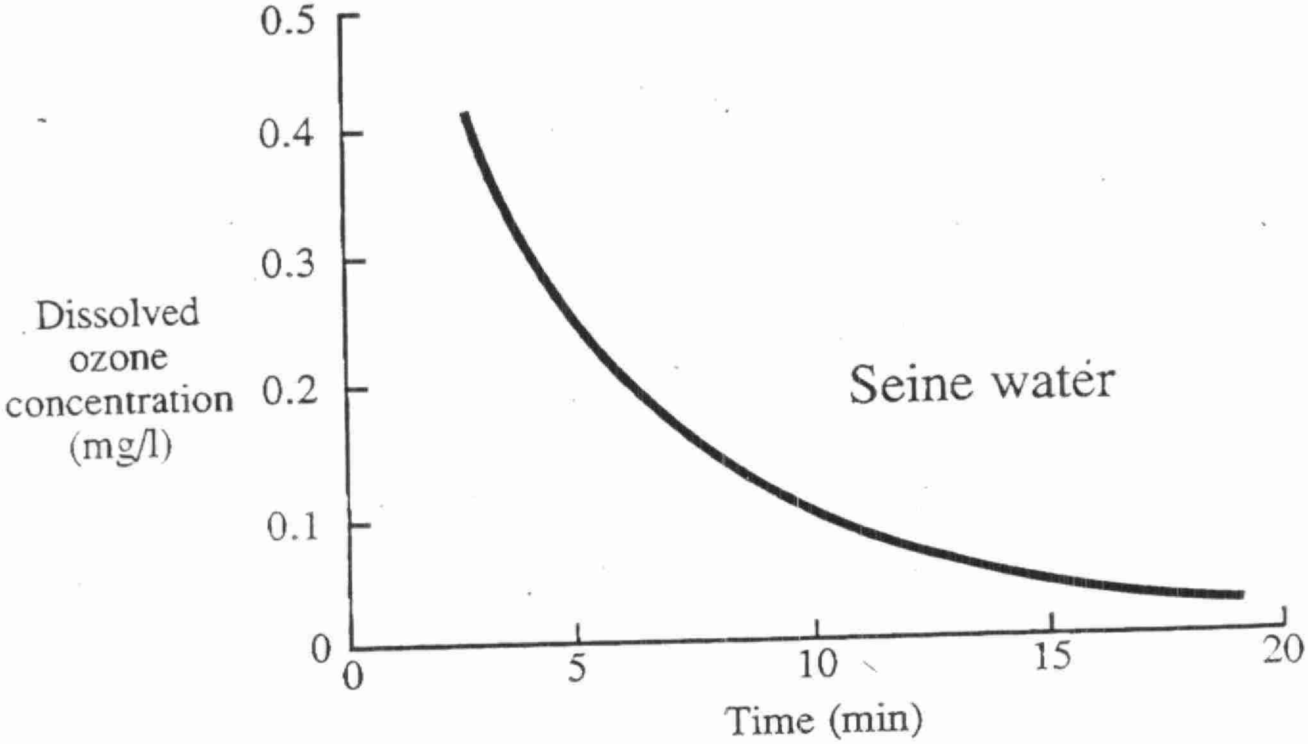


Fig. 8. Decrease in residual ozone with time (Seine water, France)

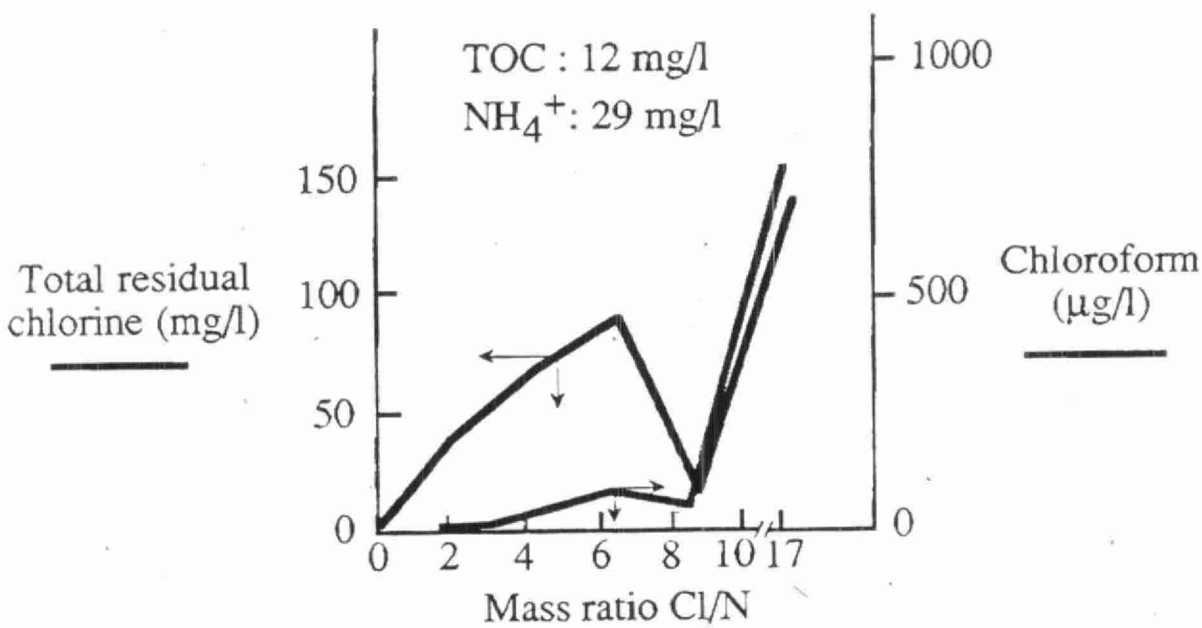


Fig. 9. Chloroform formation during conventinal breakpoint chlorination curve.

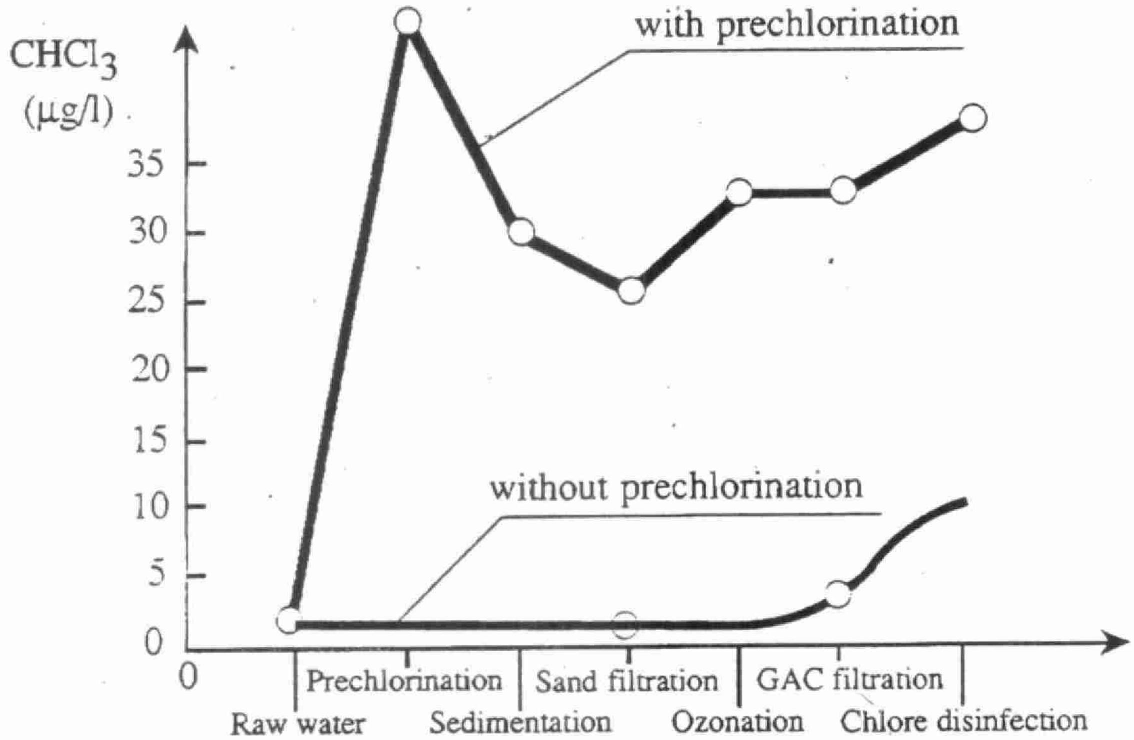


Fig. 10. Changes in chloroform concentrations during treatment with and without prechlorination.

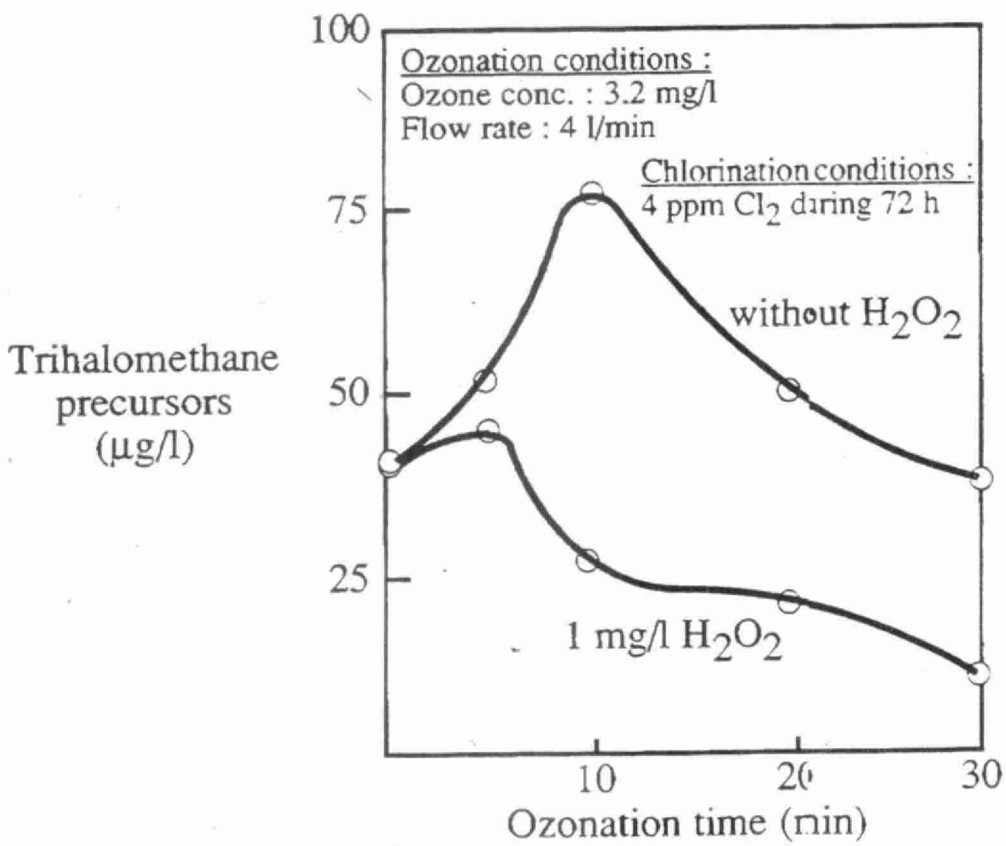


Fig. 11. Change in the THM precursors in a lake water (Cholet) during ozonation - effect of H2O2

GREATER TORONTO AREA (GTA) WASTE DISPOSAL NEEDS: AN ECONOMIC OPPORTUNITY FOR NORTHERN ONTARIO

Gord McGuinty
NOTRE Development
Corporation
North Bay, Ontario

GREATER TORONTO AREA SOLID WASTE CRISIS

"A NORTHERN OPPORTUNITY FOR SUSTAINABLE ECONOMIC DEVELOPMENT"

NOTRE DEVELOPMENT CORPORATION
North Bay, Ontario

GORDON E. McGUINTY
President

The Greater Toronto Area (G.T.A.) has received intensive scrutiny from politicians, environmentalists, industry, and the general public regarding its current solid waste crisis.

Rest assured that, based on remaining available licensed landfill capacity, **it is indeed a crisis.** However, it is important to note that, while Toronto receives, in most cases, "negative press" for its handling of their current situation, many communities in Ontario, both in the North and the South, **are experiencing similar problems.**

Additionally, during the past 24 months, the Ministry of Environment has required Metro to accept solid waste from communities located in an ever-widening area. These communities cannot adequately and safely manage their own problems.

On the lighter side, but just as relevant to the volume of waste created in Metro, is a comment made by George Kelly, Director of Solid Waste Management for Metro. He has said, "thousands of people from throughout Ontario visit our City annually for business, holidays and entertainment, **none of them take their garbage home with them".**

The question then arises, should Metro be required to look after their own problem, within Metro boundaries? Personally, I believe this is an unreasonable request based on long term planning requirements and environmental considerations.

It is important to realize that many communities who are much smaller than Metro cannot find solutions within their own municipality. The City of North Bay, one of Ontario's largest cities based on area, could not site a new landfill within its own municipal boundaries, and are now in a crisis situation. They are currently awaiting approval of a site located north of the City on **"crown land"** which is owned by the Province.

Historically, every city looked for the closest available "gravel pit" and utilized same as a "dump". There was little regard for the environment or long term planning for regional or municipal development. This approach is no longer allowed as a result of stringent Ministry of Environment regulations, or the general public's new awareness and attitude.

Consequently, every municipality must look for different, **innovative and environmentally acceptable alternatives** for the disposal of solid waste on a long term basis. The operative word is **"long term"**, because short term, stop-gap solutions are not the answer.

THE NORTHERN PERSPECTIVE - SOLID WASTE

In order to assess the economic opportunity regarding the importing of solid waste to environmentally acceptable sites in the north, we must first convey, to the communities, exactly what "SOLID WASTE" means.

RECYCLING is the environmental "Buzz-Word" of the current government. Their stress on the 3 R's of Reduce, Reuse and Recycle have **made substantial impact** on the attitudes of residents in Southern Ontario.

If, in fact, all of the population of Ontario is committed to these principles, as part of the long term solution, then "trash", and "garbage", can be **deemed a resource,** available to provide raw materials for **remanufacture and reuse.**

Our company believes that an opportunity exists to capitalize on the use of solid waste as a resource for economic development at **selected northern sites.** However, we believe that any disposal must be combined with the job **creation** and **economic stimulus** which will result from efforts to **recycle solid waste in the coming years.**

NORTHERN ENVIRONMENTAL CRITERIA

Northern Ontario will never be a place to deposit solid waste in a manner which will have any impact on our environment. **That would be unacceptable.**

However, the north has assets relative to solid waste disposal which the south will never have. Specifically those assets are the potential reuse of selected open pit mine sites. The sites are situated where an environmental impact study **should confirm** that there would **never be any influence** on water, wildlife, municipal expansion, agriculture or tourism.

The technology is in place to ensure the security of a large engineered landfill in any municipality. Keele Valley and Brock West in Metro Toronto are examples of this. However, the potential pollution from the **traffic and noise associated with the operation of these sites is a real and valid daily concern.**

Herein lies a northern opportunity. Transportation of solid waste, **via rail,** to sites where the existing infrastructure is in place and can be **"reused" and "recycled"** for the benefit of the host regions, represents such an opportunity.

ADAM'S MINE - KIRKLAND LAKE

The Adam's Mine, located south of Kirkland Lake, was closed in March of 1990, leaving over 325 **men and women unemployed.** A total economic contribution of over 40 million dollars annually to the region is no longer available.

However, the closure has also left two large pits with a **capacity of 27 million tonnes,** existing **rail infrastructure, hydro capacity, natural gas services**, and over **300,000 square feet of shops, offices and industrial buildings.** The site also has available, as a result of the iron ore mining operations, in excess of 30 million tonnes of sand cover materials which can be utilized for the operation of a landfill, and thousands of cubic meters of natural clay on site.

The site is located at the end of a Provincially maintained highway and is serviced directly by the **Ontario Northland Railway.** The ONR, in conjunction with the Canadian National, have transported over one million iron ore pellets to Hamilton annually over many years.

The opportunity exists, now that the site is closed, to reverse this rail haul, and import 1.5 million tonnes of solid waste annually for disposal and recycling.

IMPLEMENTATION

The locating of a landfill is regarded as almost "impossible" in many areas of North America, regardless of the crisis.

However, a fundamental and classic mistake is repeated in nearly every case, that being, no attempt to communicate with, discuss with, and reply to, all concerns expressed by the population "on a continuing and ongoing basis during the implementation".

Political consent from local councils is not enough.

Proponents, whether they be municipalities, private developers, or Provincial officials, must make the **firm commitment to "respond", on a daily basis, to questions and concerns.**

Based on previous experience, our company took the following approach in our Host Region of Kirkland Lake, Englehart and Larder Lake.

1. **Prior to submission or informing Toronto and the G.T.A. of the site's existence and potential, we met with local councils to conduct a detailed "information session" on the project using slides, videos and carefully prepared written data.**

2. **We researched and made contact with all special interest groups, and invited ourselves to make similar presentations.**

3. **We spoke at all local unions, service clubs, high schools and conducted a series of well advertised "Open Meetings" throughout the region.**

4. **We responded to every invitation to "debate the project".**

5. **We responded, on a daily basis, to every individual "letter to the editor", or other known opposition, with a full information package.**

The result to date has been a relatively informed region, based on over 45 presentations to more than 2000 people. We have received the support, by resolution, of the three main councils. Our project has also been named to Metro Toronto's short list of potential sites.

The most important fact is that, should this project become reality, at least two more years of the same kind of effort is required. We are currently into the second major program

designed to communicate within the region. By year end we hope to have met with more than 2000 people during the fall months.

Implementation, therefore, requires **hundreds of man hours, honest communication, and hundreds of thousands of dollars.** In our view, the public deserves no less and, in most cases, has not received this type of commitment in the past from the proponents.

THE ECONOMICS - RECYCLING AND SOLID WASTE, 1990'S

In an evaluation of the new costs associated with the rail transportation of solid waste to remote sites, there are two areas of economic consideration.

These considerations are the increased cost to Metro Toronto, and the economic benefit to the receptive Host Region. (ie: Kirkland Lake, Englehart, Larder Lake)

METRO TORONTO

It is an accepted fact that new generation landfills, with increased environmental security, greater transportation costs, and **"host community compensation packages"**, will cost significantly more than at present.

Large scale efficient landfill operations like Keele Valley in Toronto have a basic operational cost of $6.00 to $8.00 per tonne exclusive of overhead costs. Including transfer costs of $6.00 to $8.00, plus other related expenditures, brings the existing system cost to between $27.00 to $30.00 per tonne.

It is interesting to note that remote landfill sites, using specific types of abandoned mines, could prove more efficient and more environmentally sound, than existing expensive clay liners.

The planned substitution of **"pumped leachate control systems"** from pits which may be **more impermeable than existing clay sites,** could provide greater efficiencies and greater security.

However, notwithstanding these benefits, the projected transfer cost, via rail, will increase from the current $6.00 to $8.00 per tonne to $30.00 to $40.00 per tonne resulting in a new annualized average increase of approximately $28.00 per tonne.

Metro Toronto, who have direct control of 900,000 tonnes of municipal waste, would experience an annual increase of approximately $25,200,000 to its solid waste operating budget after 1994. (1)

Regarding any development at the Adam's mine site, Notre has made the **establishment of a Solid Waste Recycling Plant mandatory for the use of the site.** This will be an additional cost of some $20 - $30 Million Dollars. The funds are budgeted elsewhere in Metro's long term waste management plan, but the plant will be located in the north.

HOST REGION

Our corporation made basic commitments to the region prior to submitting our project to Metro Toronto. They included the following:

1. Minimum of 1 million dollars annually to the Host Region

2. Establishment of a Major Recycling Facility on site.

3. Commitment of a minimum of $250,000 annually to a Research and Development Facility to be established in the Host Region.

Attached is the actual **"Agreement in Principle"** which has been negotiated with Metro and the Host Region by our company. The agreement outlines the various components which will be included if the project becomes operational.

A project that will cost Metro an additional $25 million per year over 25 years, totalling a sum of at least $625 million, will result in an **"economic benefit"** in excess of $360 million to the Host Region in the North.

Moreover, the Ontario Northland can expect to receive a substantial share of the increased "transfer cost" of $30 -$40 per tonne over the same period. Again, this will result in **northern jobs, northern expenditures, and northern economic stimulus.**

This is an unequalled opportunity at a time when the north is losing manufacturing, mining and forestry jobs.

(1) Source: Metro Council Management Committee Report Number 3, August 15, 1990.

THE FUTURE OPPORTUNITY

Rarely has this Province, with its historic NORTH VERSES SOUTH grievances, had the opportunity to share in a project which could benefit many other communities who could access the north/south rail system.

Northern Ontario can provide an accessible site which can be **"recycled" and "reused"** for the economic benefit of the regions of Kirkland Lake, Englehart, and Larder Lake, while Southern Ontario, (Metro Toronto), can provide the **"raw material" and investment capital.**

The result will be a "system", supported by the rail lines of the Ontario Northland, Canadian National, and Canadian Pacific. This system could provide a means of accepting solid waste from small communities, in the north and the south, who are unable to find environmentally acceptable landfills.

Finally, as our company made it **a criterion that recycling be included in the project,** the north will have the **first and largest municipal solid waste recycling plant in the Province. Secondary industry,** relating to remanufacture of plastics, glass, etc., will find a **consistent on-site supply of product.** This would justify industries establishing on site, in the Province's **"largest, integrated waste management development", located in the north.**

SUMMARY

I offer a quote (author unknown), which I use consistently in my presentations. I find it extremely relevant to this project:

> **"A MAN WHO SAYS IT CANNOT BE DONE, IS GENERALLY INTERRUPTED BY THE MAN WHO IS DOING IT."**

Solid waste and recycling represent a tremendous opportunity for northern economic diversification. It will be interesting to see if it becomes a reality.

<u>Prepared and Presented by:</u>

Gordon E. McGuinty
President
NOTRE DEVELOPMENT CORPORATION

NOTRE DEVELOPMENT CORPORATION
North Bay, Ontario

STATEMENT OF PRINCIPLES OF
PROPOSED AGREEMENT BETWEEN KIRKLAND LAKE, LARDER LAKE, ENGLEHART AND METROPOLITAN TORONTO
(ESTIMATE $ VALUE OVER 25 YEARS)

Metropolitan Toronto will give preference to local labour for jobs created by the development and operation of the landfill and waste processing facility. ($265,000,000.00)

Metropolitan Toronto will pay into Economic Development to Kirkland Lake, Englehart, Larder Lake and the surrounding communities in the host region a payment of $1.10 per tonne of waste deposited at the site. The payment will be adjusted annually based on the Consumer Price Index (C.P.I.) all item index. ($50,000,000.00) This money will be distributed throughout the entire host region, including Kirkland Lake, Larder Lake, Englehart, all Road Boards and other unorganized areas on a per capita basis.

Establish a waste recycling plant(s) within two years after approval of the site for use, having a capacity initially to process 120,000 tonnes annually. ($40,000,000.00)

Metropolitan Toronto will provide 100 acres of the site to allow for the development of recycling technologies and industries to benefit the Host Region.

Metropolitan Toronto will pledge $250,000.00 per annum to a Research and Development Fund.

Metro Toronto will provide a grant to the communities in the Host Region of Kirkland Lake, Larder Lake, Englehart in an amount at least equal to the Kirkland Lake Commercial (industrial) Mill Rate for municipal purposes, (x) the realty assessment of the property, (+) any applicable business taxes, and further that the grant to be distributed on a per capita basis to the three communities providing services within the Host Region, be a minimum of $600,000.00 annually.

Metropolitan Toronto will receive household solid, non-hazardous waste generated by Kirkland Lake, Larder Lake, Englehart and other surrounding communities in the host region at no cost during the life of the site. ($10,000,000.00)

Metropolitan Toronto will establish a recycling area for the receipt of source separated waste and to provide special blue boxes for such materials for residents of Kirkland Lake, Larder Lake, Englehart and the surrounding communities in the host region.

Metropolitan Toronto will provide a separate area to receive large metal appliances such as refrigerators and stoves for recycling.

Metropolitan Toronto will provide a composting area for leaves and yard waste collected separately.

Metropolitan Toronto will commit to an application, under the Environmental Assessment Act, for use of the site for twenty years for waste management including waste processing and recycling, subject to this site being acceptable.

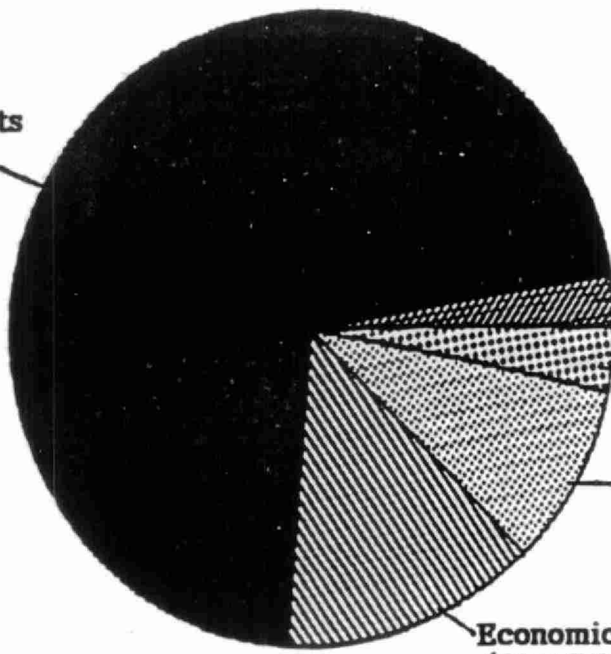
Host Region is defined as the area proposed by the Notre Development Corporation in their presentation to Metro, and to the Solid Waste Interim Steering Committee.

NOTRE DEVELOPMENT CORPORATION

Adam's Mine Project

Kirkland Lake, Ontario

RECYCLING COMPLEX & SOLID WASTE DISPOSAL FACILITY
HOST REGION
25 YEAR ECONOMIC BENEFITS



Summary of Minimum Regional Benefits

1.	Direct Wages & Benefits (150 employees)	$265,000,000
2.	Economic Development Fund	$50,000,000
3.	Research & Development Fund	$12,000,000
		$327,000,000
	<u>Additional Benefits</u>	
4.	Municipal Tax Assessment (Estimated)	$25,000,000
5.	Complimentary Solid Waste Disposal Savings	$10,000,000
	TOTAL MINIMUM REGIONAL BENEFITS	<u>$362,000,000</u>

INGROUND METHODS TO REMOVE IRON AND MANGANESE FROM GROUNDWATER - IGNACE EXPERIENCE

Dave Turnbull
International Water
Supply Ltd.
Barrie, Ontario

INGROUND METHODS TO REMOVE IRON AND MANGANESE FROM GROUNDWATER - IGNACE EXPERIENCE

Dave Turnbull
International Water Supply, Ltd., Barrie, Ontario.

BACKGROUND

In 1986, groundwater adequately supplied the Ignace population of 2400. Upgrading of the system was considered to satisfy a moderate population growth to a total of 3000 persons.

The raw water required treatment to satisfy MOE Water Quality Guidelines, however, the existing sequestration had not provided acceptable quality control. Studies by IWS Ltd. in conjunction with the MOE indicated the raw water problems were generally related to the presence of iron, manganese, hydrogen sulphide and dissolved organics. The interaction caused chemical and biological problems. Biological activity resulted in an accumulation of organic debris in the system which contributed to taste and odour complaints and created a health hazard. The taste and odour problems were reinforced by the hydrogen sulphide. Iron and Manganese supported the biological activity, causing discolouration of the water and staining of plumbing fixtures. A more comprehensive treatment process was required to treat the raw water supply and correct the water quality problems. Comparisons of several treatment processes and a pilot study demonstrated

VYREDOX METHOD

the In-Ground Biological Treatment (Vyredox Method) would provide necessary treatment economically with ancillary advantages of lower well maintenance costs and less environmental impact.

The Vyredox Method recognizes that oxygen enriched groundwater is free of Iron and Manganese. In areas where the aquifer has been recently recharged, the groundwater contains elevated levels of Dissolved Oxygen, but as the groundwater migrates through the soil, the oxygen is gradually consumed and background levels of Dissolved Oxygen approach 0.1 to 0.2 mg/litre.

We therefore consider some portions of the aquifer near the point of recharge are in an oxidizing environment but gradually change downgradient to a reducing environment. Iron and Manganese concentrations are low in the oxidizing environment but increase in the reducing zone.

The Vyredox method is based on creation of an oxidizing environment in the aquifer adjacent to a production well. Various techniques are used to achieve this condition. At Ignace, a series of fully-penetrating recharge wells were constructed around a production well. The recharge wells

VYREDOX METHOD (Cont'd)

were paired to allow production from one well to recharge into an adjacent well. The water pumped from one well was stripped of gases and saturated with oxygen before recharging the adjacent well. This pumping phase is arrested for a period of time and then the flow is reversed. This sequence is maintained and provides an elevated concentration of dissolved oxygen in the aquifer.

It has been determined the Redox Potential gradient at the edges of the oxidation zone supports manganese reducing and iron reducing bacteria. It is the biological activity which is dependent in part on a continuous source of manganese and iron to survive which provides the treatment mechanism.

IGNACE SYSTEM

At Ignace, two 38 litre/second wells provided the municipal water supply. At No. 1 and No. 2 Wells, the iron concentration was 2.5 to 3.5 mg/litre and the Manganese ranged from 0.4 to 0.5 mg/litre. A series of Geochemical Sampling Wells were installed at selected locations around each production well to monitor vertical and horizontal chemical parameters including Ferrous and Ferric Iron, Manganese, Ammonia, pH, Eh, Temperature and Dissolved Oxygen.

IGNACE SYSTEM (Cont'd)

Substantial variations were noted at the sampling points and the relative location to recharge boundaries was believed to be the cause.

A pilot study at No. 1 Well indicated the biological activity could be stimulated and after three "slug-treatments" of oxygen enriched water, the iron was reduced to 0.08 mg/litre and the Manganese to 0.22 mg/litre.

The permanent installation was designed based on four fully penetrating Vyredox Wells at each production well. The Vyredox Wells were paired and each equipped with Degassifier/ Aeration units. This allowed gas stripping and oxygenation of the groundwater before recirculating to the adjacent Vyredox Well. The zone of biological activity is controlled by the extent of the oxidation provided by the Vyredox Wells.

VYREDOX TREATMENT

The Iron concentration at each well started to reduce almost immediately after the Vyredox system was started. After about six months operation, the iron had fallen from 3.5 mg/litre to 0.3 mg/litre at No. 1 Well and from 2.5 to 0.1 mg/litre at No. 2 Well. Accompanying this decline was a gradual reduction in manganese and correction of the taste and odour complaints.

VYREDOX TREATMENT (Cont'd)

It was also noted the chlorine dosages necessary to maintain acceptable residuals in the system were reduced considerably.

VYREDOX ADVANTAGES

The Vyredox Method is a groundwater treatment approach designed to biologically reduce iron and manganese concentrations. The "in-ground" concept minimizes plant construction and property requirements. Sludge disposal is avoided and operational supervision is minimized. Chemicals are not required in the process and plugging of the production well is minimized.

The experience at Ignace satisfied these objectives partially, however, several operating problems have occurred that require further study as discussed below.

OPERATING PROBLEMS

The water quality variations in the aquifer cause distortion of the treatment zone. Consequently, certain portions of the aquifer respond differently to the treatment. It is essential that the Biological Zone is evenly distributed in the aquifer, otherwise untreated water penetrates the treatment zone and reduces the effectiveness of iron and manganese renewal. Biological plugging of the Vyredox Wells also occurs, which restrict the recharge rates. When this happens,

OPERATING PROBLEMS (Cont'd)

the iron and manganese levels rise until the wells are cleaned and recharge rates restored.

The plugging problem has resulted in higher than anticipated power costs and additional labour to regularly clean the Vyredox Wells. Studies are underway to develop a more economical and effective method of cleaning the Vyredox Wells.

CONCLUSIONS

The Vyredox Method at Ignace has demonstrated that In-Ground Biological treatment can reduce Iron and Manganese problems associated with groundwater. Iron concentrations in the raw water have been reduced from 2.5 to 3.5 mg/litre to about 0.1 to 0.3 mg/litre in the treated water.

Although operating costs associated with the treatment are not high, maintenance costs to clean the wells are higher than anticipated. If the Vyredox Wells are not regularly cleaned, the treatment deteriorates.

When an acceptable program to control the well plugging is established, the Vyredox Method will provide a valid process to effectively reduce Iron and Manganese Concentrations with minimal environmental impact.

SMALL MUNICIPAL LANDFILLS:
SUB-SURFACE CONTAMINATION AND CLEAN UP

Jim Barker
University of Waterloo
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Small Municipal Landfills:
Subsurface Contamination and Clean-up

J. F. Barker

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Abstract

Municipal landfill leachates often contain unacceptable levels of organic contaminants, particularly volatile, chlorinated hydrocarbons such as trichloroethylene, carbon tetrachloride and tetrachloroethylene (here termed volatile halocarbons) and aromatic hydrocarbons such as benzene, toluene, ethylbenzene and xylenes (termed BTEX).

An extensive zone of contaminated groundwater occurs at the North Bay landfill site. Here, natural processes have produced considerable passive remediation of halocarbons and BTEX during their migration. Dispersive dilution and biodegradation are the most significant processes bringing about attenuation, although the temporal variability of contaminants makes it difficult to quantify this attenuation. At the North Bay site, the contaminants causing the unacceptable environmental impact are phenol, reduced nitrogen, and metals such as Cu, Fe and Zn. Adding oxygen to the contaminated groundwater will encourage biodegradation of phenols and utilization of ammonia and will cause the precipitation of the metals. This suggests an in situ, aquifer clean-up strategy: employ natural or enhanced anaerobic biotransformation followed by an aerobic biotransformation polishing step to treat landfill leachate contaminants.

Groundwater Impact By Leachate From Municipal Landfills, Including North Bay

Table 1 presents the occurrence of volatile halocarbons and BTEX in landfill-leachate impacted groundwaters at municipal landfill sites, most in Ontario. Occasionally these compounds occur at concentrations high relative to drinking water guidelines. The variation between sites is large, reflecting differences in the landfilled material, site operation, groundwater flow patterns, and groundwater biogeochemical environment.

The North Bay landfill is set upon and has impacted a shallow, water table aquifer in sand. This is not an unusual situation in Ontario, although newer landfills are sited with groundwater protection in mind. The North Bay landfill has operated from about 1962 to the present. The leachate carries a high DOC load to the groundwater and so the groundwater is strongly anaerobic, with methane being generated within the plume.

Table 2 provides the typical ranges in concentration of selected parameters observed over a number of years of monitoring Chippawa Creek and wells impacted by leachate from the North Bay landfill. Well G5 is adjacent to the landfill and well AAA5 is about 700m downgradient in a discharge area adjacent to Chippawa Creek. Sample NB8 is of the Creek, upgradient of the impact, while sample SW2 is of the leachate flowing into the Creek. MOE surface water objectives and other action levels are noted.

Natural Attenuation and Clean-up in the North Bay Plume

As Table 2 indicates, the maximum concentration of most contaminants decreases during migration from G5 to AAA5. This attenuation is due to a number of processes, some specific to the particular contaminant. Just as smoke from a chimney disperses and dilutes in the atmosphere, so does leachate disperse into the natural groundwater into

Table 1. Volatile Halocarbons and Aromatic Hydrocarbons in Groundwaters At Landfill Sites. Concentrations in ug/L.

Compound	Sites					
	A	B	C	D	E	F
Tetrachloroethylene	13	nd	nd	nd	0.1	nd
Trichloroethylene	100	0.3	37	nd	750	nd
Trichloroethanes	70	nd	0.1	0.1	90	0.1
Carbon Tetrachloride	-	0.1	nd	nd	8	nd
Chloroform	-	nd	20	nd	20	2
Vinyl chloride	120	-	-	-	-	-
Benzene	110	3	70	45	50	60
Toluene	2000	nd	7500	60	1400	2600
Ethylbenzene	140	nd	1100	60	120	700
Xylenes	-	nd	1100	140	500	3500
Chlorobenzene	-	nd	3	110	nd	110
Naphthalene	-	nd	50	20	260	60

nd: not detected, generally < 0.2 ug/L   - : not analyzed

Site A: site 1, Cline and Viste, 1985; Site B: CFB Borden; Site C: Woolwich, Waterloo Region; Site D: North Bay; Site E: New Borden; Site F: Upper Ottawa Street, Hamilton (sites B to F are all in Ontario; from Barker et al., 1988).

Table 2. Ranges of Concentrations of selected Parameters - North Bay Site.
Concentrations Are In mg/L for Inorganics, ug/L for Organics.

Parameter	G5	AAA5	NB8	SW2	Objective/Std
pH	6.6-7.1	6.4-7.5	4.0-5.7	7.4-7.8	6.5-8.5
Chloride	130-650	20-200	<.4-3	10-50	none
Ammonia, as N	130-190	5-40	<0.2-.1	6-14	0.5
Phosphorus, total	<0.02	<0.02	<0.05	<.03-.6	0.03
Iron	2-120	<.1-20	.5-2	.8-12	0.3
Copper	<.009-.07	.005-.03	.025	<.01-.05	0.005
Zinc	.006-.25	<.002-.04	.02-.04	<.01-.05	0.030
Phenolics	15-70	2-20	<1-8	<1-6	1
Benzene	5-50	<1-12	nd	nd	5
Toluene	?-60	<1-3	nd	nd	2000 (EPA)
Chlorobenzene	?-30	<.1-16	nd	nd	15
Ethylbenzene	10-70	<1-15	nd	nd	700 (EPA)
Xylenes	2-190	<1-5	nd	nd	400 (EPA)

nd : not detected, usually < 3 ug/L

which it mixes. This dispersive dilution continues down the flow path. It impacts all contaminants and for non-reactive contaminants like chloride, it is the only attenuation process.

Many contaminants interact with the aquifer material in the process of sorption. Although the uptake of the contaminant onto the aquifer solids is reversed as the contaminant concentration in the water declines, the contaminant mass in the water is reduced. Also, the rate of migration of the contaminant is slowed due to its temporary residence on/in the solids. This process is well recognized in the attenuation of metals, other cations and nonpolar organics.

Chemical interactions of leachate-groundwater-aquifer solids produces precipitation of some solids and dissolution of others. For example, iron can be leached from Fe-bearing minerals in the aquifer by the anaerobic leachate.

We are becoming increasingly aware that subsurface bacteria can transform many organics into other organics or into simple inorganics, such as CO2, H2O and HCl. This research is in the "process discovery stage" with new biotransformations being reported and better insight being gained into the controls of biotransformation. It appears likely that all organics are transformable by natural bacteria under some environmental conditions. In fact, the in situ biorestoration of contaminated groundwaters is simply the creation of that correct environmental condition to enhance the natural biotransformation desired.

At the North Bay landfill, the natural attenuation has been estimated for some contaminants and has been attributed to dispersive dilution and, in some cases, to biodegradation. Sorption of trace organics seems to be minimal and is not a significant attenuation mechanism. Table 3 indicates the attenuation occurring in groundwater between a well near the landfill (G5) and a well in the discharge zone (AAA5). Attenuation of chloride is by dispersive dilution and its attenuation was used to define the extent of dispersive dilution upon other organic contaminants. Attenuation beyond

that found for chloride is attributed to biotransformation of the organics in the anaerobic, methanogenic plume. Considerable passive remediation of volatile halocarbons and BTEX is concluded, except for benzene and chlorobenzene, whose concentration declines are not significantly different from the non-reactive chloride.

Table 3. Attenuation of chloride and some trace organics between G5 and AAA5, North Bay leachate plume.

Solute	Typical Concentrations (ug/L)		Attenuation, G5 to AAA5
	G5	AAA5	as % G5 conc.
Chloride	330000	70000	79 %
Benzene	30	5	83 %
Toluene	50	<1	> 98 %
Ethylbenzene	60	2	97 %
Xylenes	110	4	96 %
Chlorobenzene	35	7	80 %

Laboratory and field studies have recently demonstrated that such anaerobic, methanogenic conditions are conducive to the biotransformation of many volatile halocarbons (Acton and Barker, in submission). These studies are consistent with the interpretation of biotransformation of volatile halocarbons in the North Bay plume. One liability of this process is the possible formation of vinyl chloride from tri- and tetra-chloroethylene. Vinyl chloride is being determined in the North Bay groundwater.

The natural biotransformation of some aromatic hydrocarbons was not expected. Anaerobic biotransformation of these compounds is rare in laboratory experiments and is usually very, very slow. However, both laboratory and field experiments at the North Bay site (Acton and Barker, in submission) found that toluene, ethylbenzene and xylenes were rapidly biotransformed in the anaerobic aquifer. Half lives were often less than i month. Although these half lives are considerably shorter than those that would be consistent with the observed persistence of many of these organics to the discharge area, thought to be 3 to 6 years travel time from the landfill, they nevertheless confirm the interpretation of some anaerobic biotransformation during transport in the North Bay plume. It should be noted that benzene, the aromatic with the lowest action level, was rather recalcitrant, both in our experiments and apparently in the North Bay plume.

Aquifer Clean-up: The Need and the Opportunities

At North Bay, the natural attenuation during groundwater migration is sufficient for all but phenol, ammonia, P, Cu, Fe, and Zn (see Table 2). All except ammonia exceed MOE surface water objectives upstream. It is interesting to speculate that much of the offending Fe in the leachate probably comes, not from the landfill but from leaching of iron from aquifer material. In any event a leachate plan was required and the City of North Bay has implemented leachate collection from drains adjacent to the landfill. The leachate is pumped into the sewer system for eventual treatment in the City's treatment plant. This is commonly termed "pump-and-treat" remediation. Essentially, for non-degraded contaminants such as metals, pump-and-treat is really just the relocation of the contaminants. For degradable organics the sewage treatment holds some potential for actual destruction of the contaminant, although the performance of sewage treatment plants for trace organic treatment is uncertain. The above concerns, coupled with the

expense of pumping and treating contaminated groundwater, has produced considerable interest in alternative technologies. One alternative is in situ treatment.

Most in situ groundwater clean-ups have used in situ biodegradation. Contaminants for which treatment has been claimed include petroleum hydrocarbons, organic solvents and chlorinated hydrocarbons (see Wilson et al., 1986. for a review). Can this method be applied to clean-up chemically-complex, landfill leachates?

Our research at the North Bay site has been evaluating the enhanced in situ biodegradation of volatile halocarbons and BTEX. We have attempted to stimulate denitrifying, sulphate reducing and fermentative bacteria through the addition of nitrate, sulphate and primary substrates such as acetate and glucose, respectively. Disappointingly, none of these additions enhanced biodegradation of the target organics significantly. On the other hand, both lab and field experiments demonstrated that natural biodegradation for many of these organics was occurring in the plume. This could be built into clean-up plans. For example, the approach at North Bay might be to follow natural anaerobic biotransformation in the aquifer with an aerobic biotransformation step, either in the aquifer at the discharge zone via oxygen addition or on the surface during overland flow. This combination of anaerobic and aerobic processes has been used in wastewater treatment to deal with general organic material and harmful organisms in sewage. Our research at other field sites demonstrates that benzene which is recalcitrant under anaerobic conditions is rapidly biotransformed under aerobic conditions (Barker et al., 1987, for example). Also, products of anaerobic metabolism, such as phenol and vinyl chloride are known to degrade under aerobic conditions. Similarly, ammonia is expected to be consumed or nitrified aerobically. Metals will be precipitated aerobically and can be returned as sludge to the landfill.

The advantage of in situ clean-up must be expressed in terms of costs savings in both the "pump" and "treat" aspects. Groundwater is not withdrawn, so energy is saved. Much of the treatment is in situ, without the need to maintain high temperatures as in sewage treatment plants, so energy is saved. The treatment is likely to be much slower than in above-ground systems, but the long residence time of contaminants in aquifers such as at North Bay partially negates this disadvantage.

Research like ours has not considered the complex chemistry of landfill leachate plumes in total. This needs to be done in future "treatability" research. Our conclusion from North Bay is that halocarbons and BTEX are not likely to be major impacts. Natural attenuation is sufficient. For other sites where natural attenuation is not sufficient, stimulation of natural anaerobic biotransformations in situ, followed, if necessary, by in situ or on surface aerobic treatment should attenuate most organic and reactive inorganic contaminants sufficiently. This confidence needs to be critically tested before this approach to aquifer clean-up becomes routine.

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SUMMARY OF PRESENTATION
TO THE INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE

"DEVELOPING SUSTAINABILITY -- THE CHALLENGE OF THE 90'S"

Elizabeth May
Cultural Survival Institute
Ottawa, Ontario

SUMMARY OF PRESENTATION

TO THE INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE

FROM ELIZABETH MAY

"DEVELOPING SUSTAINABILITY -- THE CHALLENGE OF THE 90'S"

The state of the planet demands fundamental change, i.e. greenhouse effect, ozone depletion, long range transport of air pollution, loss of biological diversity, population pressure, marine pollution, deforestation, etc. The World Commission on Environment and Development identified the solution under the term "sustainable development". The term has been widely accepted, by the Commonwealth countries, the Group of Seven leading economic powers, the Government of Canada and by many corporate and industry groups. But few people have any clear sense of what sustainable development is -- on a local, regional, or national, much less international scale.

In recent negotiations toward international protocols on various global threats, notably ozone and greenhouse, the least developed countries have been demanding the transfer of technology as a major component of any sustainable development strategy. How will the technology transfer debate affect Canada? Will it disintegrate into a divisive North/South dialogue? What are the implications for Northern Ontario of the current international climate around sustainable development?

There can be no definitive answers to these questions, but understanding the nature of the debate is critical. The challenge of the 1990's will not be to guarantee economic development, but rather, to develop sustainability in all human activities. Innovative technologies will play a critical role in that process, but technology will not save us. Our behaviour must change. Our habits must change. And it is a change in the way we think that will play the decisive role.

NORTHERN ONTARIO HERITAGE FUND CORPORATION - MANDATE, OBJECTIVES AND PROGRESS

Arne Sorenson
General Manager
NOHFC
Sudbury, Ontario

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

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NORTHERN ONTARIO
HERITAGE FUND CORPORATION

HISTORY

FALL 1986	THE IDEA-ROSEHART REPORT
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MAY 1987	BUDGET ANNOUNCEMENT
WINTER 87/88	CABINET FINE TUNING
APRIL 1988	BUDGET ANNOUNCEMENT
APRIL 1988	LEGISLATIVE DEBATE
JUNE 1988	ROYAL ASSENT-BILL 116
JULY 1988	BOARD ANNOUNCED
JULY 1988	INITIAL BOARD MEETING
1988-1990	MONTHLY MEETINGS

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

PRECEDENTS

YEAR TO YEAR ROLL OVER

OWN BANK ACCOUNT

EARNS INTEREST

$1 MILLION UPPER LIMIT
(BOARD LEVEL)

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

SUBCOMMITTEE AND MANDATES

SINGLE INDUSTRY COMMUNITIES

TECHNOLOGY DEVELOPMENT

SMALL BUSINESS

SPECIAL PROJECTS

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

DETAILED TERMS OF REFERENCE

SINGLE INDUSTRY COMMUNITIES

ISSUE

- SINGLE INDUSTRY COMMUNITIES EXPERIENCING ECONOMIC DISRUPTION

OBJECTIVES

- FOSTER THE LONG TERM ECONOMIC DEVELOPMENT
- FACILITATE ORDERLY RESTRUCTURING

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

ELIGIBILITY CRITERIA

. ECONOMIC DEVELOPMENT OFFICER/COMMISSION

. ECONOMIC DEVELOPMENT/ ADJUSTMENT PLAN

. INTERMINISTERIAL COMMUNITY TASK FORCE

REVIEWER

. INTERMINISTERIAL COMMUNITY TASK FORCE

FINANCES

. UP TO 50% OF PROJECT COSTS

. UP TO $3 MILLION PER COMMUNITY

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

DETAILED TERMS OF REFERENCE

TECHNOLOGY DEVELOPMENT/TRANSFER

ISSUE

- RESEARCH, DEVELOPMENT AND ADAPTATION OF NEW TECHNOLOGY IN THE RESOURCE INDUSTRY

OBJECTIVES

- INCREASE THE USE OF NEW TECHNOLOGY BY THE RESOURCE SECTOR

NORTHERN ONTARIO HERITAGE FUND CORPORATION

ELIGIBILITY CRITERIA

. A NORTHERN INDUSTRY/RESEARCH PARTNERSHIP

REVIEWER

. PREMIER'S TECHNOLOGY FUND

FINANCES

. UP TO 50% OF PROJECT COSTS

. NORMALLY, UP TO $1 MILLION

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

DETAILED TERMS OF REFERENCE

SMALL BUSINESS

ISSUE

- SUPPORT GROWTH AND DEVELOPMENT OF SMALL BUSINESS

OBJECTIVES

- CREATE AND STABILIZE PERMANENT JOBS
- INCREASE COMPETITIVENESS OF SMALL BUSINESS
- DIVERSIFY THE ECONOMY

NORTHERN ONTARIO HERITAGE FUND CORPORATION

ELIGIBILITY CRITERIA

- ESTABLISHMENT, EXPANSION, DIVERSIFICATION OR MODERNIZATION OF SMALL BUSINESSES

REVIEWER

- NODC, MTR, MNR, MNDM

FINANCING

A) MANUFACTURING OR PROCESSING

- UP TO 50% OF APPROVED COSTS
- OR UP TO $50,000 IN FORGIVABLE LOANS
- LOANS OVER $50,000 ARE NEGOTIABLE

B) PUBLIC SECTOR INFRASTRUCTURE

. UP TO 75% OF APPROVED COSTS

. OR $200,000 WHICHEVER IS LESSER

C) INDUSTRIAL INFRASTRUCTURE

. UP TO 50% OR $100, 000

D) RESOURCE DIVERSIFICATION & DEVELOPMENT

. UP TO 75% OR $75,000

E) TOURISM DEVELOPMENT

. PLANNING & FEASIBILITY STUDIES

. TOURISM FACILITY MARKETING

- 50% TO A MAXIMUM OF $20,000

. REGIONAL EVENTS/ATTRACTIONS

- 50% TO A MAXIMUM OF $50,000

DETAILED TERMS OF REFERENCE

SPECIAL PROJECTS

ISSUE

- ADDRESS THE STRUCTURAL BARRIERS TO NORTHERN ECONOMIC DEVELOPMENT

OBJECTIVES

- REDUCE STRUCTURAL IMPEDIMENTS TO ECONOMIC DEVELOPMENT
- INCREASE THE VARIETY, AMOUNT AND VALUE ADDED OF NORTHERN GOODS AND SERVICES
- STIMULATE MAJOR PRIVATE AND PUBLIC SECTOR INVESTMENT

NORTHERN ONTARIO HERITAGE FUND CORPORATION

ELIGIBILITY CRITERIA

- NO SPECULATIVE INFRASTRUCTURE PROJECTS
- PROJECT OF REGIONAL SIGNIFICANCE, CLIENT POPULATION OF 250,000
- NON-GOVERNMENT PARTNER, PRIVATE FIRM, TRADE ASSOCIATION, UNIVERSITY, HOSPITAL, RESEARCH INSTITUTE

REVIEWER

- APPROPRIATE MINISTRY OR AGENCY

FINANCES

- UP TO 50% OF A PROJECTS COST
- HEALTH PROJECTS OVER $25 MILLION $5 MILLION LOCAL CONTRIBUTION MAY RECEIVE UP TO $3 MILLION

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

PROCESS

NORFUND

. SMALL BUSINESS ASSISTANCE

. BUSINESS AS USUAL

. PROGRAM REVIEW COMMITTEE

NEW PROGRAMS & PROJECTS

. MEETING WITH GENERAL MANAGER

. INITIAL ANALYSIS

. BOARD DIRECTION

. IN DEPTH ANALYSIS BY MNDM/NODC/MNR/MTR/ETC

. BOARD DECISION

. >$1 MILLION TO MANAGEMENT BOARD

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

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HELENE HAWN - SECRETARY

DIANE WATTS - RECEPTIONIST

- SAULT STE. MARIE

NORTHERN ONTARIO HERITAGE FUND CORPORATION

BOARD MEMBERS

JEAN-PAUL AUBE - TIMMINS
PATRICIA BAIN - THUNDER BAY
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PATRICK GILBRIDE - THUNDER BAY
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WALLACE MCKAY - SIOUX LOOKOUT
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JOHN ROBERT - VAL CARON
KENNETH RUBIN - CHAPLEAU
MATT RUKAVINA - KAPUSKASING
LUCIE SEGUIN - NORTH BAY
MILAN SPOLJARICH - RED ROCK

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

<u>ACTIVITIES TO DATE (AUGUST 20, 1990)</u>

<u>NORFUND</u>

. $11.9 MILLION IN ASSISTANCE

. $67.1 MILLION IN TOTAL INVESTMENTS

. 345 PROJECTS

. 911 FIRST YEAR JOBS

<u>TEMFUND</u>

. 100 THOUSAND

. 810 THOUSAND IN TOTAL INVESTMENTS

. 1 PROJECT

<u>SINGLE INDUSTRY</u>

. 2 MAJOR PROJECTS BEING EVALUATED

. 1 PROJECT FOR $5.0 MILLION CURRENTLY BEFORE MANAGEMENT BOARD

<u>TECHNOLOGY</u>

. $10.0 MILLION IN ASSISTANCE

. $62.9 MILLION IN TOTAL INVESTMENTS

. 7 PROJECTS

<u>SPECIAL PROJECTS</u>

. $36.7 MILLION IN ASSISTANCE APPROVED

. $138.1 MILLION IN TOTAL INVESTMENT

. 26 PROJECTS

<u>TOTAL ASSISTANCE</u>

. $63.7 MILLION

<u>TOTAL INVESTMENT</u>

. $268.9 MILLION

NORTHERN ONTARIO
HERITAGE FUND CORPORATION

OTHER PROPOSALS

. 44 APPLICATIONS ARE BEING EVALUATED BY THE NOHFC AND BY APPROPRIATE AGENCIES OTHER THAN NORFUND

. 4 APPLICATIONS ARE BEING EVALUATED FOR TEMFUND

DECLINED/WITHDRAWN

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NORTHERN ONTARIO
HERITAGE FUND CORPORATION

WHAT'S HAPPENING

- BOARD REVIEW OF SERVICE SECTOR STUDY COMPLETED, IMPLEMENTING A SMALL BUSINESS PROGRAM FOR SEPTEMBER 1990
- INFORMATION SYSTEMS ANALYSIS UNDER WAY
- FIRST ANNUAL REPORT, DETAILED BROCHURES, APPLICATIONS AND POSTERS ARE AVAILABLE
- SMALL ADVERTISING CAMPAIGN UNDERWAY
- ADVERTISING AGENCY OF RECORD IS HENDERSON AND ASSOCIATES
- COMPLETING NEGOTIATIONS FOR MOUS WITH MONITORING AGENCIES
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- FIRST INTERIM PROGRAM EVALUATION FOR THE PERIOD ENDING MARCH 1990 UNDERWAY
- TEMFUND

WATERSHED MANAGEMENT: SUSTAINING THE ENVIRONMENT AND THE ECONOMIC DEVELOPMENT

Merilyn Twiss
Ministry of Natural Resources
Sudbury, Ontario

WATERSHED MANAGEMENT: SUSTAINING THE ENVIRONMENT AND ECONOMIC DEVELOPMENT

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Abstract

The World Commission on Environment and Development focussed world-wide attention on the concept of sustainable development, suggesting that development should be planned to meet today's needs without compromising the ability of future generations to meet their needs. Watershed management and wetlands protection can be considered key components of sustainable development. The special functions and values of wetlands are better recognized now than they were in the past. There have been a number of initiatives recently to aid in the identification and protection of wetlands. These include development of evaluation systems for wetlands, a draft policy statement on wetlands prepared by the Government of Ontario, property tax rebates through the Conservation Land Act to property owners who protect Classes I to III wetlands on their property, partnerships between government agencies and special interest groups to acquire and protect wetlands, the development of the North American Waterfowl Plan and education programs promoting wetlands protection. To successfully achieve the goals of sustainable development, watershed management and wetlands protection individuals, special interest groups, government agencies, industries, and businesses must communicate and cooperate with each other.

Introduction

In recent years, it has become obvious that economic stability is directly linked to maintenance of a healthy environment. As Kerr et al.(1987) point out, "The importance of the environment to the Canadian economy cannot be overstated. Over 40 percent of the Gross Domestic Product (GDP), 33 percent of the labour force and 52 percent of our exports can be directly related to economic activities which are dependent on the environment." The concept of sustainable development has received world-wide attention,

largely as a result of the work of the World Commission on Environment and Development, commonly referred to as the Brundtland Commission. The Brundtland Commission, which had multi-national representation, was appointed by the United Nations in 1983. The major recommendations of this group centre around the precept that mankind's survival depends upon the establishment of a balance between environmental protection and economic development, thereby ensuring protection of the resource base for future generations. Achieving this balance will require protection of existing resources to prevent loss of sustainability in any segment of the environment, and rehabilitation of degraded environments to an acceptable sustainable level.

It is clear that the goals of sustainable development will only be met if all parties in government, business, and industry work to ensure that all decisions take into account the impact and influence exerted on the natural environment. Educators also have a responsibility to ensure that educational programs incorporate and present the concepts of sustainable development. Watershed management and wetlands protection are key elements of sustainable development.

Sustainable Development and Watershed Management

The World Commission on Environment and Development (1987) defines sustainable development as "development that meets the needs of the present without compromising the ability of future

generations to meet their own needs." Manning (1990) suggests though that it may be impossible to define clearly. He states that it is a broad goal like social justice, or, " a higher order social goal implying alteration of the human/biosphere relationship to provide all that is needed to support the full range of human and ecological values, equitably, and in perpetuity." The goal of sustainable development can be described as "the maintenance of the environment resource base to sustain those functions which maintain life and socio-economic activity," with the objective being "to modify demand for, or manage supply of, environmental resources in an anticipatory fashion so that unacceptable outcomes are made less probable"(Manning, 1988).

These definitions all imply strong communication links and cooperation between different levels of government, industries and the business community. Watershed management has also traditionally involved representatives from varied backgrounds (Mitchell and Gardner, 1983) and can be seen as an extension of sustainable development. As a concept, watershed management is also difficult to define. In some cases, it seems to focus on prevention of only one or two key problems such as flooding (Harvey, 1983), water pollution (Gouin, 1983), or wildfire (Berg, 1989). Other watershed management programs encompass a wide range of issues or goals, such as low flow groundwater maintenance, fisheries and wildlife management, public health, aesthetics, timber resources management, flood control, erosion

control (often related to agricultural programs), waterfront resources management, provision of recreation and hydro-electric projects (Klinka et al., 1980; O'Riordan, 1983; Maitland Valley Conservation Authority, 1984; Kawartha Region Conservation Authority, 1987; The Metropolitan Toronto and Region Conservation Authority, 1990).

A common focus seems to be that almost all watershed management plans rely upon cooperation between various jurisdictions and agencies, and most incorporate a public consultation and information program for the watershed planning area. Watershed management can be considered comprehensive planning where, ideally, all uses of the land, water, and associated resources are assessed by considering their impact on other uses and the natural resource base as a whole.

The Ontario Ministry of Natural Resources has also adopted this type of integrated resource management to ensure that management strategies for one program, for example wildlife population management, are not in conflict with management strategies for other programs such as timber management or provincial parks.

Wetlands have been identified by the Ministry of Natural Resources as essential natural resources which are important to Ontario's economy (Ontario Ministry of Natural Resources, 1984) and they should be considered integral components of a watershed. Wetlands are considered in the integrated resource management planning process.

Wetlands Management

Wetlands are transitional areas between land and water and can be described as areas covered either seasonally or permanently with shallow standing water (usually less than two meters deep) or where the water table is close to or at the surface (Ontario Ministry of Natural Resources and Environment Canada, 1984, and National Wetlands Working Group, 1988). Characteristically they have hydric soils and vegetation types which are predominantly hydrophytic or water tolerant. They can be divided up into four major classes known as swamps, marshes, fens, and bogs.

In the past, many have viewed wetlands as useless, unattractive areas. It is estimated that approximately 75 percent of southern Ontario wetlands have already been lost as a result of urban encroachment, land clearance, drainage and filling (Ontario Ministry of Natural Resources and Ontario Ministry of Municipal Affairs, 1988). This negative perception of wetlands is gradually changing, though, as the values of wetlands become better understood. Their special values and functions include maintaining and improving water quality, helping to control flooding, providing habitat for fish and wildlife, including some threatened and endangered species, providing outdoor recreation and tourism opportunities, biological diversity, commercial plant and animal production, aesthetic appeal and landscape diversity, providing research and education opportunities, water storage functions, providing increased biomass energy, sediment retention

and nutrient recycling (Ontario Ministry of Natural Resources, 1984,Bond et al., 1988, Bardecki, 1989, and Cox et al., 1990).

The City of North Bay uses a site near a wetland area to dump snow which has been ploughed from the city streets in winter. Water sampling conducted in the wetland this summer showed very high levels of chlorides, presumably from the de-icing salts used on the roads, immediately adjacent to the area where the snow was deposited. Water samples taken only a couple of hundred meters from this site (with dense cattail growth between the two sampling sites) showed an approximately 90 percent reduction in the chloride levels. This is an excellent example of the ability of a wetland to filter out pollutants and protect water quality. Waterfront cities which might be forced to close public beaches because of pollution would be well advised to protect existing wetlands in the surrounding area, and possibly even consider rehabilitating or restoring wetland areas, if possible.

Wetlands also tend to act as giant sponges, holding excess rainfall or runoff during peak periods and gradually releasing it later, thereby protecting groundwater and low flow water levels. The costs of protecting wetlands through planning processes may be minimal in comparison to the costs associated with emergency measures required during a flood, or those of engineering and construction projects to redirect or control flood waters. It has been estimated that wetlands in Ontario provide outdoor recreation and tourism benefits through activities such as

hunting, fishing, and bird-watching, which add up to 53 million user-days per year for seven million residents. In addition, they are a source of commercial products such as fur, wood, and wild rice valued at over 300 million dollars annually (Ontario Ministry of Natural Resources, 1984).

It is not always possible to place a dollar value on an individual wetland or wetland complex to determine just how important it is, though. Recently there have been several projects aimed at formulating an evaluation system for wetlands which would make it easier to assess their worth and make appropriate planning decisions. The "Wetlands Are Not Wastelands" project, jointly sponsored by Wildlife Habitat Canada and Environment Canada, has identified three methodologies to be considered (Bond et al., 1988, and Bardecki, 1989). The first approach, called "willingness-to-pay", usually uses a questionnaire to collect data directly from individuals. The information collected is used to establish a hypothetical or contingency market for non-market goods or services. The "opportunity cost" approach assesses the net monetary benefit of the alternate use of the area which is given up in order to maintain the wetland in its natural state. The third method is termed the "cumulative impact" approach, and it requires the identification of social values which are provided by the wetland, and of these, which are threatened by the proposed alternate use of the area. The proposed alterations are then evaluated relative to a series of specific standards reflecting

the range of applicable societal goals and objectives. For example, there might be pre-established standards for acceptable water quality or maintenance of habitat for endangered species. It has also been suggested that an integration of all three approaches would be suitable in some cases (Bardecki, 1989).

Another type of evaluation system has been developed for use in that portion of Ontario which lies south of the Precambrian Shield (Ontario Ministry of Natural Resources and Environment Canada, 1984). This system enables the evaluator to assign a point score to each of four main components of the wetland: Biological, social, hydrological, and special features. Point scores for the individual components are then totalled to arrive at an overall score for the wetland. Based on this score, it is possible to assign the wetland to one of seven ranks or classes. Wetlands ranked as Class I or II are considered provincially significant. Regionally significant wetlands are those ranked as Class III, while Class IV to VII wetlands are considered locally significant. This evaluation system was developed to serve as an aid for land use decision-making. The development of a similar evaluation system for northern Ontario is currently being considered. The existing evaluation system is the basis of a draft policy statement on wetlands which clearly establishes the importance the Government of Ontario places on protection of wetlands (Ontario Ministry of Natural Resources and Ontario Ministry of Municipal Affairs, 1988). The goal of this draft policy statement is to identify and protect all provincially

significant (Class I and Class II) wetlands, with municipalities, planning boards, and resource management agencies being expected to incorporate this goal in their land use planning objectives. More specifically, it is intended that official plans will identify and protect provincially significant wetlands, specify the information required and the matters to be considered when development is proposed on or adjacent to these wetlands and identify the planning mechanisms required to implement the policies. Where zoning orders or zoning by-laws are used, the policy states that provincially significant wetlands should be placed in a restricted zoning category where only wetlands and compatible land uses are permitted. The Ontario Ministry of Natural Resources is responsible for providing wetland mapping, information, and technical assistance when requested.

Other steps are being taken to protect wetlands on private lands. The Conservation Land Act provides incentives to landowners to protect Classes I to III wetlands on their property by providing grants in the amount of up to 100 percent of the property tax paid.

Partnerships have been formed with government agencies and groups like Ducks Unlimited Canada and Wildlife Habitat Canada to acquire and protect wetlands threatened with conversion.

At times wetlands management is an international issue, particularly when the focus in on management of habitat for migratory species like waterfowl. A North American Waterfowl

Management Plan has been prepared with support from the federal governments of Canada and the United States, various provincial and state governments including Ontario and private organizations including Ducks Unlimited and Wildlife Habitat Canada. Projects under the plan are called "Joint Ventures" and one is underway now in the lower Great Lakes-St.Lawrence area. This is considered one of the highest priority wetland areas in Ontario.

Education programs to ensure that landowners understand the unique values of wetlands and the importance of protecting wetland habitat are key components of a wetlands management program. The responsibility for these education programs has been assumed by groups such as Ducks Unlimited, as well as by government agencies such as the Ontario Ministry of Natural Resources.

Many individuals and agencies have a role to play in wetlands management. It is encouraging to see the partnerships and linkages which have already been formed in working towards the common goal of wetlands protection.

Conclusion

Sustainable development is an admirable goal towards which we should all be working. Watershed management and wetlands protection are key components in a program aimed at achieving sustainable development.

Fortunately, in northern Ontario the loss of wetlands has not been occurring at the alarming rate experienced in southern Ontario. This does not mean it cannot happen here, though. We all have a responsibility as individuals, and as government, industry and business representatives to ensure that the unique and valuable features of wetlands are maintained for future generations.

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REDUCING OPERATING COSTS OF SEWAGE TREATMENT

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ENERGY CONSERVATION

Ladies and Gentlemen:

Energy conservation in water and sewage plants. I am sure that there are many of you here in the audience today saying to yourself "this topic does not really apply to me, I have been operating my plant efficiently for twenty years or more and I have the operation right under my thumb".

Well, if you would bear with me for a new minutes perhaps, I can give you a few ideas or at least get you thinking to the point where you will go back home and look around that old familiar plant one more time.

When people think of energy conservation, the first thing that comes to mind is electrical energy, but there are other forms of energy such as mechanical energy or human energy that is also wasted at times.

First and foremost though is electrical energy. It is the prime candidate for wastage as it is used so extensively in all plants for so many unit operations.

One of the most obvious areas is the area of plant lighting. Energy

efficient lighting systems allows your plant to enjoy the same or improved lighting levels at lower costs. To assist your plant in making the switch to energy efficient lighting, Ontario Hydro will provide up to 50 percent of the cost of converting your lighting system to a more efficient one.

The Energy Efficient Lighting Plan provides incentives for companies to reduce their energy demand. I will now outline some of the details of the major incentive categories but please bear in mind that there are other demand reducing measures that can be considered on an individual basis.

a) Energy Efficient Fluorescent Lamps

Energy saving fluorescent lamps produce nearly the same amount of light as standard fluorescent bulbs but will reduce the amount of electricity by about 15%.

b) Compact Fluorescent Lamps

Energy efficient company fluorescent lamps are designed to replace power hungry incandescent lamps and provide quality illumination at a fraction of the operating cost.

c) Lighting Redesigns

Retrofits of existing systems to those incorporating a more efficient light source such as incandescent to metal halide or mercury vapour to high pressure sodium lamps can yield substantial savings in energy, maintenance and lamp replacement costs.

d) Reflectors

Fluorescent reflectors can cut lighting costs up to 50% by allowing the removal of half of the lamps and ballasts from a fluorescent fixture.

e) Timers and Electric Eyes

The use of timers and electric eyes or photocells can also reduce lighting costs. Lights put on timers can be programmed to come on at

opportune times rather than just turn the lights on when you leave the building at 4:00 p.m., thus leaving the lights operating needlessly during all the daylight hours plus the weekends. The use of photocells will also only allow the lights to operate after darkness falls, but unfortunately, also will provide intermittent operation during all lighting storms.

Electric Motors

Without a doubt, electric motors contribute to or represent a major portion of the electric bill. Motors drive more than equipment, and they also drive a significant portion of your operational costs. They account for up to 75% of the total electricity bill in industrial plants and 50% in commercial facilities. In an effort to conserve energy, Ontario Hydro has embarked on a program to make these motors run more efficiently.

The major advantage of High Efficiency Motors is the direct energy savings that they provide.

This new design results in a motor that uses 3% to 8% less electricity than standard motors to do the same amount of work which results in a

reduced electrical bill and also lowered water treatment costs.

High Efficiency Motor Plan

The high efficiency motors plan is designed to encourage your facility to purchase energy efficient motors by paying part of the cost differential between them and standard motors.

Under this new incentive plan, new and replacement motors from 1 to 200 horsepower which meet or exceed the Ener Mark Motor Efficiency Levels qualify for a $12 per horsepower cash rebate.

Rebates range from a minimum of $50 to $2,400 per motor. There is no limit on the number of rebates a customer may receive.

I would encourage everyone to examine this avenue as there are some very big savings to be realized in this area. The old style electric motors, while they are very rugged and long lasting are very inefficient. It should be remembered that when their old motors were designed and specified, hydroelectric power was extremely cheap and high efficiency was not

really a consideration.

An area that should be examined very closely for any power savings is sewage pumping stations and, in particular, the larger stations. These stations are built and designed with a minimum twenty year design life and may be equipped at the onset with pumps specified for twenty year design flows. This means that you may be operating a very large horsepower pump to pump low flows. I realize that you only pump what sewage is in system but this in turn leads to very short pumping cycles which means excessive starts and stops on the pumps. Excessive starts not only leads to high demand charges (which sets your hydro rate for the billing period) but is also extremely hard on the associated electrical starters, pump/motor bearings, check valves, piping system, etc.

If a screw pump is used, there again, horsepower is wasted in terms of operating a large screw pump, gear boxes, wear, etc.

As an example, I have recently examined a pumping station that is equipped with two 300 HP screwflow pumps and a 75 HP normal duty pump. The small pump is capable of pumping 5,600 gpm but normally

operates at a flow of 1,100 gpm. This results in a normal electrical load of approximately 30 HP. It was found that a small 20 HP submersible pump can be used to carry the base load (1,100 gpm) thus resulting in a small saving in electrical power but a huge savings in terms of mechanical wear and tear on the pumps. As you probably know, screw flow pumps are designed with a life based on "x" number of cycles or rotations. If you utilize this life operating at 20% of the pump's specific capacity, you have operated that pumps extremely inefficiently over its life span. Although the pump has only pumped 20% of its available capacity, we have experienced 100% wear on the bearings, leading edge of the pump, upper and lower shafts and the gear box/motor combination.

Air Blowers

Of all the motorized components used in a WPCP by far the largest utilizer of electrical energy are the air blowers. In many cases, I would assume that this component alone comprises 60% of the hydroelectric bill. This of course is largely determined by the number and size of pumping stations associated with your project. In a plant such as Parry

Sound that utilizes 14 pumping stations, this component may only represent 10% of the hydroelectric bill but in a project such as Smooth Rock Falls which has only one pumping station, this may account for 80% of the total hydroelectric bill.

Keeping these factors in mind, every effort must be made to control and optimize Dissolved Oxygen levels in the aeration tanks. Under normal operating conditions, the D.O. level should be kept between 2.0 - 5.0 mg/L. While D.O. levels in excessive of this may make the plant a little easier to operate in terms of buffering capacity in the aeration tanks, you are really paying a premium for this luxury.

It should be kept in mind that during spring run off conditions, the raw sewage or aeration influent could have a D.O. level as high as 8.0 ppm prior to aeration. Care must be taken at this time to maintain sufficient aeration to keep the MLSS in suspension.

In practice, it has been found that during most normal operations, one air blower is sufficient to maintain operations for 20 hours/day but staff have been known to put on the second blower to meet the peak demand

for the four hour period and then just have the two blowers on for convenience.

An investment of two thousand dollars for a good D.O. meter will certainly pay for itself in a short period of time and for those of you who are of Scottish descent, the Winkler Method will provide accurate D.O. readings at a much lower cost, i.e. reageants and a few single lab components.

Many of the older WPCP's have been equipped with coarse bubble aeration facilities which in recent years has been replaced with fine bubble aeration units. The increase in oxygen transfer rates with the fine bubble aerators is from normally 6% to 12% which again results in a significant cost savings in electrical energy.

Standby Diesels

Most facilities such as Water Pollution Control Plants, Water Treatment Plants and Sewage Pumping Stations are equipped with standby diesel generator sets to meet increased environmental controls and demands.

We, all being conscientious supervisors, managers, or operators etc. agree that these diesels should be operated on a regular basis as part of our preventative maintenance program to keep them ready for operation to meet any environmental emergencies.

These units are then run faithfully by the maintenance personnel on a regular basis as predicated by the maintenance work order or data card, etc. Often these units are run under no load or very lightly loaded conditions which result in poor efficiency, wet stacking in the exhaust system and a general wastage of fuel.

Ideally, you should examine your hydroelectric records and flow records to determine those peak periods and then run the diesel generator during these periods. This not only reduces your electrical bill but also provides a maximum and very efficient workload for the diesel generator set.

Water Treatment Plants

There is an area in Water Treatment Plants that is notorious with respect

to wastage of hydroelectric power and that is the constant operation of pumps in a closed water system.

Again, these pumps are usually designed for twenty year design flows and if the growth does not materialize or the flows are lower than expected, large amounts of hydroelectric energy are wasted in pumping extremely low flows during the night periods. Flows during this period should be examined carefully with the result that a jockey pump can be utilized that may only be 20-30% of the size of a normal duty pump. For the most part in small communities, a high head, very low volume pump will suffice as we are usually just trying to maintain pressurized conditions.

Heating

In the past, a lot of WPCPs, WTPs, storage sheds/workshops, etc. were constructed utilizing electric heat. This was relatively economical to install as it required simple controls, no ducting, is relatively quick to heat a building and easy to repair or service. In addition, hydroelectric power was cheap to purchase and this was not a big consideration.

Recent increases in the cost of hydroelectric power have made the cost of electric heating extremely expensive. As an alternative, we have retrofitted several installations with natural gas furnaces with a payback period of less than two years which will result in significant savings.

Certain WPCPs may also use gas or oil fired furnaces c/w all ducting etc. for heating purposes. In these cases, the hot air that is normally exhausted out of the blower room as a waste product could possibly be ducked into the furnace intake or cold air plenum. This will recover all of this heat that is normally wasted to atmosphere and result in significant gas savings, as the temperature of the intake air would be raised considerably.

Sludge Haulage - Digester Operation

The never ending battle of trying to maximize solids in aerobic digesters is a big problem in many WPCPs. Achieving a solids level much in excess of 3% seems to be an impossibility at times with the result that we end up hauling sludge that is 97% water. Wouldn't it be nice to be able to somehow thicken the sludge to say 6% solids which would

reduce our hauling costs by 50%!

This can usually be achieved by installing a simple gravity sludge thickener on the waste sludge line immediately prior to the digester.

By the simple addition of a flocculant such as a polymer, sludge levels can easily be increased from 2 to 6 or even 8%. Usually the governing factor on how heavy the sludge is concentrated is the ability to pump the sludge from the thickener.

Most experts you consult on this matter will emphatically claim that sludge cannot be thickened in this manner. When you site a specific case where such a thickener is installed and working, they claim it is site specific. All I can say is that I have been involved in the design and construction of three of these units and they all work, and they work well.

The immediate advantages and savings are:

1. Reduction of sludge haulage by at least 50% (savings in gas or diesel fuel).

2. More efficient use of aeration in the digester, i.e., more solids per unit of air for mixing and digestion.

3. Less area needed for sludge holding lagoons (fuel and labour saved on construction).

4. Much reduced hydraulic loading to sites when sludge is utilized.

Sludge Irrigation System

This hauling of sludge at any time is a very expensive proposition especially if the sludge is utilized. Fortunately from an environmental view point, very little sludge in this Region is disposed of but rather is utilized for agricultural purposes. This utilization program usually has a high price tag as the sludge must be digested, hauled to a field and spread.

Unfortunately, this being Northern Ontario, there are many days when we cannot get on the field due to frost, snow, rain, impassable access roads, etc. which results in the sludge being put into a transfer lagoon.

Now the sludge has to be mixed again, pumped again into a truck, hauled and then spread.

If you are fortunate enough to have access to one of these sludge irrigation units, weather becomes much less of a factor and sludge can be utilized under nearly all climatic conditions.

The energy cost savings are significant as the sludge is only handled once instead of twice, not to mention monies saved in mixing, repumping, etc.

It is hoped that in this short presentation, that I have perhaps saved someone some money in their overall operation. If so, I will consider this time extremely well spent and utilized. If not, perhaps everyone will go home and while they are walking around that old familiar plant will give it a careful look keeping the ideas presented in this paper in mind. Again, if this is achieved, I would be extremely satisfied.

This now concludes my presentation and I would be happy to try and answer any questions.

DETERMINING PCB DESTRUCTION
AND REMOVAL EFFICIENCIES (D.R.E.S)

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DETERMINING PCB DESTRUCTION AND REMOVAL EFFICIENCIES

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ABSTRACT

This paper is a brief overview of the measurements required in determining the performance of an incinerator for destroying PCBs, which is currently specified by Destruction and Removal Efficiency (DRE). The emphasis is on the gas sampling and analysis.

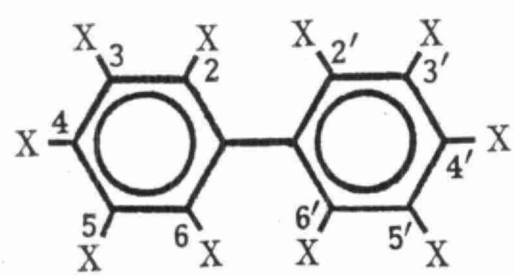
Flue gas sampling of PCBs and the subsequent sample recovery and processing are lengthy and cumbersome. Discussions are given on obtaining a representative sample, sampling strategy and quality assurance.

Incineration is likely to change the composition of the residual PCBs which are not destroyed, and may produce interfering compounds which are not removed in the clean-up process used prior to analysis. The complications and the analytical methods for dealing with them are discussed.

DRE determination requires that the analytical methods used, including how PCBs are quantified, be clearly and explicitly stated.

INTRODUCTION

Polychlorinated biphenyls (PCBs) are derivatives of biphenyl in which one to ten of the hydrogen atoms are substituted with chlorine. There are 209 distinct PCB compounds or congeners, ranging from three monochloro isomers to one decachloro congener. Figure 1 shows the nomenclature for indicating the number and positions of the chlorine substitutions.



x = H or Cl
n = number of chlorine substitutions

n	Prefix	No.isomers
1	mono	3
2	di	12
3	tri	24
4	tetra	42
5	penta	46
6	hexa	42
7	hepta	24
8	octa	12
9	nona	3
10	deca	1

Figure 1. PCBs: $C_{12}H_{10-n}Cl_n$ - Structure and nomenclature

Commercially produced PCBs contain certain mixtures of congeners and are known by various tradenames, of which Aroclor is the most well-known. For example, in Aroclor 1242 and 1254, the digits 12 refer to biphenyl, and the last two the chlorine contents in weight percents. An exception is Aroclor 1016, which is similar to 1242 in chlorine contents but different in congener composition.

PCBs have high thermal and chemical stability, a property which is desirable in many industrial uses, such as dielectric fluids in capacitors and transformers. At the same time, this property is a cause of environmental concern. PCBs are persistent, known to be bioaccumulated and biomagnified, and moreover, suspected of causing long-term adverse health impacts.

The wide use of PCBs and the lack of recognition of their potential hazards are illustrated by the following US estimates[1]. The cumulative sales up to 1974 were 510,000 t, of which 350,000 t escaped to the environment and were distributed as follows: air (27,000 t), water (54,000 t) and land (270,000 t). Although the manufacture and use of PCBs have now been banned, they still exist, either in containment or as contaminants.

Thermal decomposition or incinceration is one of the options available for "detoxifying" or destroying PCBs. This paper presents a brief overview of the measurement of incinerator performance for this purpose.

INCINERATION

Complete reaction between PCBs and oxygen at an elevated temperature produces carbon dioxide, water and hydochloric acid. However, imperfections in incinerator design or operation result in either poor mixing between the reactants, or the reaction time or temperature being lower than necessary, or all of these. In practice, therefore, the reaction may not be complete and hence, residual PCBs are still present.

Destruction and Removal Efficiency (DRE) is defined by:

$$DRE = \frac{W_I - W_O}{W_I} . 100\% \tag{1}$$

where W_I is the PCB feed rate, and W_O is the PCB air emission rate. Note, therefore, that:

- the removal of PCBs in the scrubber is included,
- the residual PCBs which may be present in the ash or scrubber effluent are not considered,
- formation of products of incomplete combustion is not considered, and
- the allowable emission is not constant but proportional to the feed rate.

The feed or emission rate is determined from:

$$W = F c = F \frac{y}{V} \tag{2}$$

where F is the total flow rate, c is the PCB concentration in the stream, V is the volume or mass

of the sample collected, and y is the mass of PCBs in the sample.

DRE determination is part of a "trial burn," the term used for the assessment of the performance of an incinerator system. The scope of a trial burn exceeds that which is required only for DRE determination, and hence will not be described here. However, to give some appreciation, a sample list of the required measurements, which must be conducted in triplicate, is given in Table I. In practice, though, the details of what and how measurements are taken must be negotiated on a case-by-case basis between the incinerator operator and the regulatory agency. Those not familiar with trial burns should find Ref. 2 very informative as a starting point.

DRE DETERMINATION

As discussed in the previous section and shown in Table I, DRE determination involves:

- measurements of flow rates of the waste and the flue gas,
- collection of samples of the waste and the flue gas, and
- processing and analysis of the samples collected.

DRE can then be readily computed from equations (2) and (1).

Procedures for conducting the above are specified in the references cited in Table I. Of these, only the flue gas sample collection and processing, and PCB analysis will be discussed, since these are the most complex in DRE determination.

Flue Gas Sampling: MM5 Method

Figure 2 is a schematic diagram of the sampling equipment. It consists of a *heated probe,* which is partially inserted into the stack and through which the flue gas sample is withdrawn; a *filter* for particulate removal, which is housed in a heated box; a *condenser* to cool the flue gas; a *sorbent trap* containing XAD-2 resin which preferentially adsorbs PCBs and other semi-volatile organic compounds; a *set of impingers* for collecting moisture and PCBs that may pass through the resin; a *pump* to withdraw the sample, and *flow measuring devices* to determine the sampling rate and the volume of the sample collected. In addition, a *pitot tube* is used to measure the gas velocity in the stack.

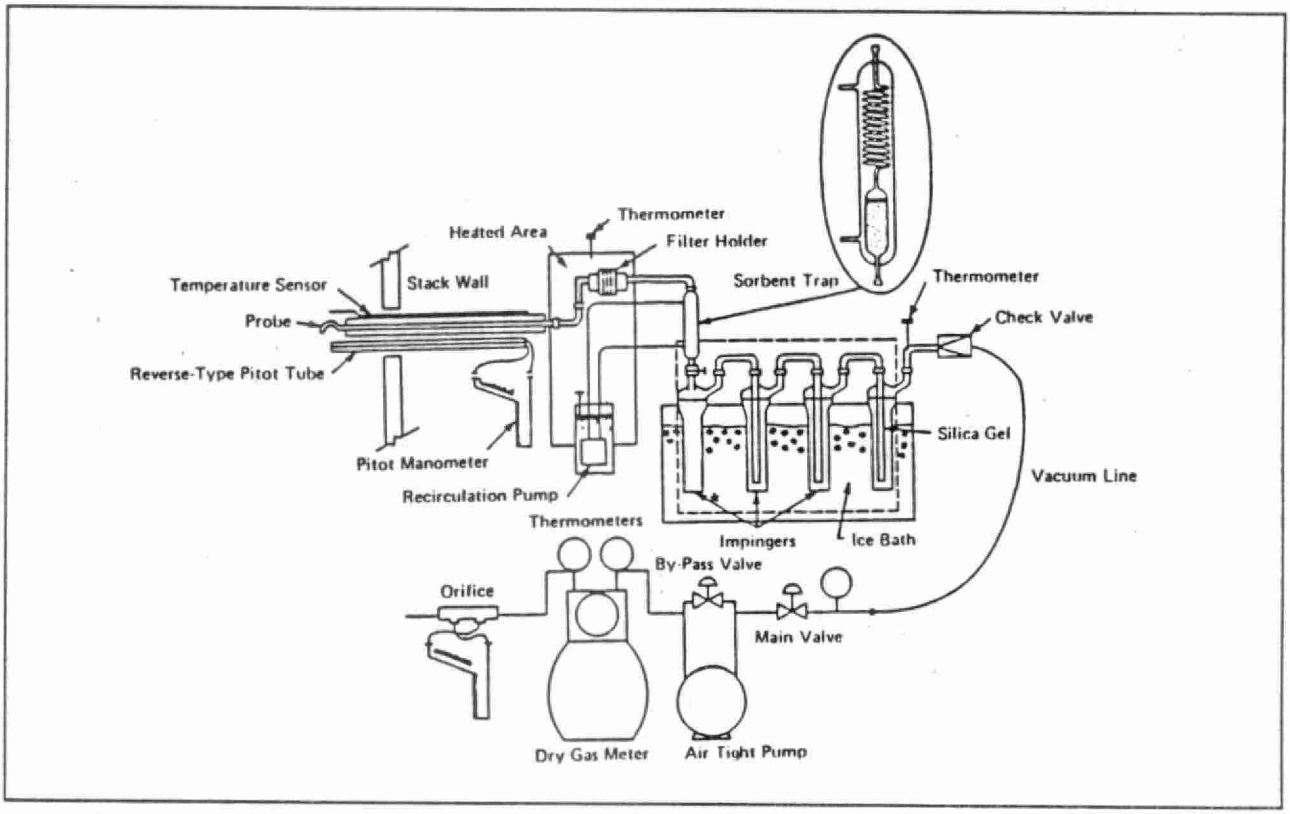


Figure 2. MM5 Sampling equipment

The principle of operation is simple. A measured volume of flue gas is sampled, and the PCBs collected are recovered, processed and quantified. The protocol is, however, quite complex and lengthy, as can be seen in the following examples.

■ **Obtaining a Representative Sample.** The flue gas may contain particulates on which PCBs are adsorbed. To ensure that particulates are sampled representatively, the sampling port must be located where segregation does not occur. A minimum distance from any disturbance, such as a bend, is thus specified in terms of length-to-diameter ratio. Also, isokinetic sampling must be conducted, which means that the sample gas velocity at the probe tip must be equal to the flue gas velocity at that location. Furthermore, the probe tip must be placed at different radial locations in the stack during sampling. The locations of this "traversing" are chosen to divide the stack cross-section into equal areas.

■ **Sample Recovery and Processing.** The collected PCBs may be present in all parts of the sampling equipment. These are recovered as follows: from the resin and the filter by Soxhlet

extraction, from the impinger solutions by solvent extraction, and from the glassware by rinsing with a suitable solvent. The PCB-containing solvents can then be combined or analysed separately.

Two additional steps are usually necessary prior to analysis: a clean-up process to remove compounds which may interfere with PCB analysis, and a concentrating step to increase the PCB concentration for analysis. Note that if compounds other than PCBs are to be analysed, then separate clean-up processes may have to be carried out to remove, in this case, PCBs as contaminants. Therefore, not all the PCBs collected are available for analysis. This has an implication on how much sample is to be collected.

Recovery and processing procedures are lengthy and cumbersome. Extreme care and considerable operating experience are needed to minimize PCB losses.

■ **Minimum Volume of Sample.** A sufficient volume must be collected so that the PCBs collected can be quantified, or if they are below detection, such results will show that the minimum DRE is exceeded. The following equation can be used:

$$V_m = \frac{1}{c_m} Y_d \frac{100}{R} \frac{100}{f} \qquad (3)$$

where

V_m is the minimum sample volume, say in m^3,

c_m is the target or minimum concentration of PCBs in the flue gas, say in $\mu g/m^3$. For example, to demonstrate a DRE of 99.9999%, c_m may be selected to produce a DRE of 99.99999%, thus allowing for a ten-fold "safety margin." This value can be computed from equations (1) and (2) since the PCB feed rate and the flue gas flow rate are known in a trial burn.

Y_d is the minimum amount of PCBs that can be quantified by the detector in the analytical instrument, in μg.

R is the recovery efficiency, in %. (100-R)% is thus the fraction of PCBs lost in the recovery and processing steps. The value of R is estimated from past experience, either from independent laboratory experiments or the results of surrogate spiking, which will be described later.

f is the ratio of PCBs injected into the analytical instrument to those collected in the sampling equipment, in %. This value depends on whether the sample is split for different clean-up processes, the extent of the concentrating step and the volume of injection into the analytical equipment.

Note that because of the limitations imposed by the isokinetic requirement, the availability of probe tips (which then set the sampling rate) and the sampling time, there may not be a wide range of sample volume that can be collected. In this case, f must be adjusted, by adopting an appropriate processing strategy, to ensure that the purpose of demonstrating a minimum DRE can still be achieved.

▪ **Quality Assurance.** This is an important aspect which covers many areas, too numerous to describe in this paper. Examples include the use of "blanks," proving cleanliness of glassware and resin, leak checks, calibration of flow meters and pitot tubes. These are necessary to ensure that the equipment used is in good working order and the procedures are properly followed. For the sample recovery, processing and analysis steps, surrogate spiking is used. Surrogates are compounds which are not present in the flue gas, but have similar behaviour to PCBs and can be distinctly identified and quantified in the PCB analysis. Examples are isotopically labelled PCBs, fluorinated and brominated biphenyls. Known quantities of these compounds are added into the sampling equipment. Comparison between the added and measured quantities can thus be used as an indication of the errors in the above steps.

Analysis

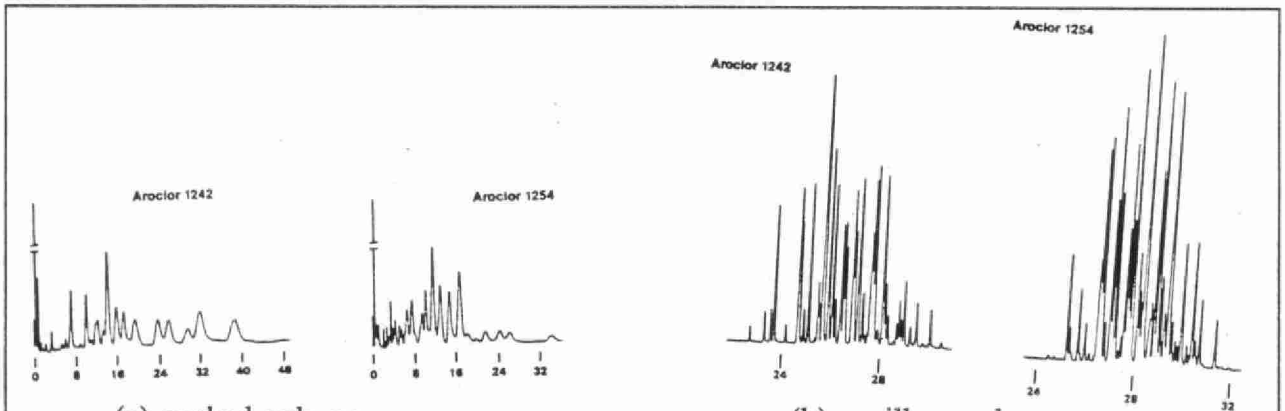
Gas chromatography (GC), coupled with a detector, such as an electron capture detector (ECD) or a mass spectrometer (MS) is the most commonly used method. The separation in the GC provides compound identification (only partially since two or more compounds could have the same retention time) and the detector response provides quantitation. MS also provides identification or confirmation on the basis of mass spectrum.

If the composition of the PCB congeners is known, "finger printing" with GC-ECD can be used. Commercially produced PCBs have distinct and consistent chromatograms, such as those shown in Figure 3a. Quantitation can be made in terms of weight of the mixture which

matches the finger print of the sample. There is no need to identify and quantify individual congeners. This approach is applicable to, for example, analysis of waste or contaminated soil where the PCB source is known and there has been no change in composition.

The difficulties in PCB analysis for DRE determination stem from the fact that incineration is likely to change the congener composition, and furthermore, it may produce interfering compounds, such as chlorobenzenes, which are not removed in the clean-up process. Finger printing can no longer be used, and hence different approaches must be adopted, as described below.

■ **Quantitation of Individual Congeners.** The first requirement is to have a better separation than what is adequate for finger printing. For example, Aroclors contain 50-70 congeners which are not fully separated for the purpose of finger printing. Figure 3b shows the better separation obtained using a capillary column, as compared to that obtained using a packed column shown in Figure 3a.



(a) packed column (b) capillary column

Figure 3. Sample chromatograms of Aroclors (Source: Supelco, Canada Catalogue 28, 1990)

MS is also needed since ECD does not provide information on compound identity. Even with GC-MS, individual congener analysis may not be practical or possible. Instead, only isomer group analysis is carried out, which produces results in terms of weights of mono-, di-, trichloro biphenyls...etc.

■ **Derivatization.** All the PCB congeners are converted to decachloro biphenyl (DCB) by reaction with antimony pentachloride. The resulting single compound analysis is much simpler:

GC-ECD can be used and quantitation can be expressed as weight of DCB. The disadvantage is that false positives may occur from the conversion of non-PCB compounds into DCB. GC-MS may thus still be necessary to confirm the presence or absence of such compounds.

CONCLUDING REMARKS

DRE is only one measure of incinerator performance. It does not address all the potential environmental concerns resulting from PCB incineration, such as residual PCBs in the ash and scrubber effluent and the formation of incomplete combustion products which may in fact be more toxic than PCBs.

PCB analysis is complex, and furthermore, interpretation of the results is not clear cut. Unlike the case of a single compound, the PCBs in the waste and in the air emission are different, although the same term is used. A consistent way of expressing PCB quantities in both streams is thus needed. As indicated in the text, different expressions are used depending on the analytical methods chosen. Therefore, in a trial burn, the methods used and how the results are quantified must be clearly and explicitly stated.

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TABLE I.
Sample List of Measurements in an Incinerator Trial Burn[a]

STREAM	SAMPLING			ANALYSIS (c)
	Parameter	Frequency	Method (b)	
Waste feed	**Flow rate**	**Contin. or average**	**Various (d)**	
	Composition property	**Grab, composited**	**S004 (liquid) S006, S007 (solid)**	**POHCs,** Cl, metal ash, HHV, µA, viscosity
Chamber ash	Generation (average)	End of run	Weight	
	Composition	Random; end of run, composited	S006	POHCs, Leaching
Scrubber influent and effluent	Flowrate	Continuous or average	Flowmeter, tank level	
	Composition	Grab, composited	S004	POHCs, pH, TDS
Flue gas	**Flow rate**	**Spot check or continuous**	**Pitot tube or flow meter**	
	Composition	***3-4 h integrated***	***MM5***	***Semi-volatile POHCs (e)***
		4 pairs, 20 L integrated	VOST	Volatile POHCs
		2-3 h integrated	M5	Particulates, metals, acid gases, moisture
		Spot check	Orsat or others	CO_2, O_2, CO
		Continuous	Continuous analysers	CO, CO_2, O_2, THC acid gases (plant's montrs)

(a) Adopted from Ref. 2. Those needed for PCB DRE determination are shown in **bold**, and those discussed in this paper are ***italicized.***

(b) Sxxx refers to methods given in Ref. 3; MM5 and VOST in Ref. 4 (Methods 0010 and 0030, respectively).

(c) POHCs: Principal Organic Hazaradous Constituents (eg. PCBs); HHV: high heating value; µA: ultimate (elemental) analysis; TDS: total dissolved solids; THC: total hydrocarbon.

(d) Depending on waste form (liquid or solid) and mode of feeding (continuous or batch).

(e) Various methods for PCB analysis are given in Ref. 4 (Methods 8080, 8250, 8270) and Refs. 5 and 6.

MUNICIPALITIES, A VISION FOR THE FUTURE - FROM A PRACTICAL SUSTAINABLE POINT OF VIEW

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MUNICIPALITIES, A VISION FOR THE FUTURE -
FROM A PRACTICAL SUSTAINABLE POINT OF VIEW

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There is little doubt that if a public debate were to be held in any municipality in Northern Ontario with the topic "that sustainable development is a desirable objective for our municipality", the motion would be passed unanimously. This would probably happen even though most of the participants have a rather foggy idea of what sustainable development is really all about. It has become a public catch-phrase, a sign of the "greening of the baby boomers" as public and private priorities move in response to a growing concern that the human race must be preserved to live upon this earth in a "green and pleasant land".

It has been suggested that a layman's definition of sustainable development is "development which meets the needs of the present generation without compromising the needs of future generations". There is little doubt that much of the development which is taking place in our cities and in our countryside does not meet the above definition of sustainable development. This paper will present some ideas on how we can move from the grossly imperfect present to something closer to our ideal and in particular, what the implications will be for municipalities in Northern Ontario. This paper will deal with some general issues and concludes with specific recommendations for change in the way in which development proposals are processed through the municipal planning procedure.

I believe that it is important at the outset to recognize that the development process which has built the cities and rural municipalities of Northern Ontario will likely continue, in a modified form, throughout the lifetime of all of those present at this conference. The development process is based on the principal that entrepreneurship is the heart of the north and incremental development is acceptable as long as it can be made politically palatable.

On the other hand, the pure environmental planner would take the approach that nothing, short of a complete and comprehensive urban and rural plan, should be used as a guide to development. I believe there is a danger in expecting sustainable development to come about simply through the imposition of harsh and rigid plans. It would certainly be a wonderful world if municipal councils could stand behind the kind of recommendation which the following excerpt from a recently written planning report, dealing with a proposed rezoning application in a Northern Ontario city, proposes:

".......the rate of growth of the municipality and the availability of serviced land within existing areas must be addressed. Once the land and housing needs are determined, the allocation of these needs to a compact efficient urban form locating urban extensions in a logical and co-ordinated fashion as possible. This information can be incorporated in the official plan as a guide to council in its decision making process. Without this data and information, incremental decisions are premature."

The reality of the situation is that an attempt to impose planning regulations and restrictions which echo the above quotation are doomed to failure on purely political grounds. Rather, I feel that we must direct our energies towards modifying, supplementing, and augmenting the present planning process and the available legislation in such a waythat the objectives of sustainable development are achieved, albeit gradually, on a staged basis.

Specifically, I have the following recommendations regarding issues which could well be further addressed through the planning process and legislation now in effect:

<u>Logical Allocation of Available Resources</u>

- The Ontario Ministry of the Environment has recently put into effect regulations known as the "Reasonable Groundwater Use Criteria" which are applied, among other things, to urban developments in the rural areas of municipalities where sewage disposal and water supply is provided through on-site facilities on individual lot basis. The Reasonable Groundwater Use Criteria are an excellent example of the way in which sustainable development can be reasonably assured in the planning process. The regulations require that development be only permitted to the extent that groundwater quality is not impaired at the boundaries of the development, and the ability to incorporate other similar development on both upstream and downstream lands is preserved. This approach could be extended beyond simply the application to groundwater quality. It could also apply to noise impact, visual impact, traffic generation, and even, in the extreme, to the provision of soft services such as social programs, fire protection, and policing. Legislation is in place which could be modified by the issuance of appropriate regulations. The planning process already recognizes the imposition of such regulations and would be able to accept these new constraints.

Sustainable Development Compliance Studies

- A practical and implementable procedure to assure that reasonable attention has been paid to the issues of sustainable development will be for municipalities to require a proponent to prepare a report to show how sustainable development issues have been incorporated into the design of a project. This could be either at the rezoning or draft plan stage, depending upon whether the development is of an industrial/commercial nature, or residential nature. Such a report would deal with, among other issues:

* Orientation of streets and buildings

* Landscaping for energy conservation

* Street patterns and walkways to encourage energy conservation and transportation through providing alternates to automobile travel, such as walkways, cycle paths, and access to public transit

* Compliance with the principals of allocation of available resources as indicated above.

To make these things happen, the three following ingredients are required at the municipal level:

- Education

Education is required at all levels of society, to convince people that the principals of sustainable development must somehow be incorporated into our daily lives if the environmental future of our country, our continent, and indeed our planet, is to be assured. While there is little doubt that enormous strides have been made in this field the last decade, there is still a gigantic task to be achieved which will need the best efforts of individuals and organizations who have environmental concerns, and the requirement that these efforts be, to the largest extent, co-ordinated so as to optimize results.

- Political Will

Political will to implement sustainable development procedures will not come about without the education programs referred to above. Political will generally reflects the mood of the

public. If the public demands that sustainable development be taken seriously, then the political will to make sustainable development happen will likely come about.

- Resources

There is no such thing as a free lunch. If sustainable development is to be implemented in our municipalities, additional resources will be needed - resources of money, resources of staff, and resources of time. Generally speaking, municipal staffers are even presently overrun with the multiplicity of regulations to be checked and abided with at every step of the development process. There is little doubt as we move towards implementation of sustainable development policies, this situation will deteriorate and additional staff at the municipal level will be required with resulting financial implications for both the consumer, and, ultimately, the tax payer. Without the education programs referred to above and the political will to make these things happen, the prospect for successful implementation of sustainable development is bleak.

These are the areas where emphasis should be placed in the immediate future.

LEACHATE TREATMENT

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The Use of Innovative Technology to Treat Municipal Landfill Leachate

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1.0 INTRODUCTION

Leachate is produced when water seeps through wastes deposited in a landfill. It is typically a complex wastewater, containing both inorganic and organic contaminants. Leachate will vary in composition from site to site and over time and, consequently, can be difficult to treat.

The McDougall Landfill is located in McDougall Township, a few kilometres east of Parry Sound, Ontario. This landfill was opened in the early 1970s and is still in operation. It accepts municipal, commercial and industrial non–hazardous wastes. In earlier hydrogeological site investigation studies done by Gartner Lee Ltd., a leachate plume was identified. Part of the leachate flows north and discharges beneath McDougall Swamp which then flows into McDougall Creek. The other portion flows south and discharges through some seeps and springs into Agnes Lake.

In July 1990, Environmental Strategies Ltd., a subsidiary of Gartner Lee Ltd., conducted treatability studies on the leachate from the McDougall Landfill site. This was done to assess the effectiveness of selected treatment technologies that would be suitable for use not only at McDougall Landfill, but also at other municipal landfills in Northern Ontario with similar leachate problems. The selection of the treatment technologies was based on the experience of our staff and on extensive literature review. This paper discusses the results of the investigation of the use of membrane technology, activated carbon and anaerobic biodegradation to treat landfill leachate.

2.0 METHODOLOGY

Landfill leachate was pumped from a 125 mm ID recovery well, which was located to intersect the leachate plume. Because of the relatively low yield of the well, the water was pumped into a holding tank to permit field trials to be ran on the design flow rates of the treatment equipment.

Several treatment methods were investigated during the on-site trials at the landfill:

- microfiltration (MF) followed by reverse osmosis (RO),
- addition of sodium hydroxide to the leachate followed by MF and RO, and
- use of granular activated carbon (GAC) to treat the concentrated stream produced by RO.

All of the sample analyses were carried out by the Ontario Ministry of the Environment Laboratory in Rexdale, Ontario and the membrane technology equipment was provided for the study by the Environmental Emergencies Technology Division, Environment Canada in Ottawa, Ontario.

2.1 MICROFILTRATION

Microfiltration is a physical separation process that involves the filtration of particles in the size range of 0.1 to 10 microns. Two crossflow Enka Microdyne^R Modules (model MD 080 TP 2L) were used in the unit. Each module contains 43 polypropylene MF membrane tubes with an inner diameter of 5.5 mm and pore size of 0.2 microns. The membranes were activated with isopropyl alcohol prior to transportation to the on-site trials at the landfill.

2.2 REVERSE OSMOSIS

Reverse osmosis is accomplished by pumping a dilute aqueous solution at high pressure over a semi-permeable membrane. The water is preferentially transported across the membrane due to the difference between the osmotic pressure and the hydrostatic pressure of the solution. Reverse osmosis can be used to remove dissolved solids and or free phase organic contaminants from water. Two Filmtek spiral would seawater membranes were used in series at a pressure of 800 psi (5530 kPa).

2.3 ACTIVATED CARBON

Activated carbon used in the on–site trials was Filtrasorb 400 obtained from Calgon Canada.

RESULTS

The on–site field studies were carried out July 15 to 20, 1990. The results of this work and of the literature review will be presented in a paper at the conference.

WATER SEWAGE GRANT UPDATE

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ONTARIO MINISTRY OF THE ENVIRONMENT

WATER AND SEWAGE GRANTS

The Ministry of the Environment, under the legislative authority of the Ontario Water Resources Act, and subject to policies approved by Management Board of Cabinet, provides grants to municipalities for the construction of municipally-owned sewage and water works.

The policies provide for assistance in the construction of communal facilities, repair and renewal of private water and sewage systems (as an alternative to more expensive communal works only), and the construction of rural water pipelines, in certain circumstances.

Grant levels range from 15% to 85%, depending on municipal population.

I. DIRECT GRANT PROGRAM

1. COMMUNAL SEWAGE AND WATER WORKS

All municipalities may apply for funding assistance for communal sewage and water works in accordance with the following:

1.1 Large Municipalities

Funding Level: 15% of the eligible costs after deduction of federal or other grants. The funding level may be increased to one third of the eligible costs for that

part of the work necessary to solve a health or environmental problem.

Eligible Costs: The capital cost of major components of communal water and sanitary sewage works. Major components include: water supply intakes, water treatment and storage facilities, trunk feedermains, sanitary sewage treatment facilities, outfall sewers, trunk sanitary sewers, sanitary sewage forcemains, and associated pumping stations.

Construction costs are based on the lowest, responsible, public tender.

Priority Review: Projects are selected for award of grants by means of an assessment system.

1.2 Small Municipalities

Funding Level: $33\frac{1}{3}$% to 85% of the eligible costs after deduction of federal or other grants.

Funding level is based on the population of the community where the problem area exists. Communities with a population of 1,000 or less receive the maximum grant of 85% and communities with a population of 7,500 receive the minimum grant of $33\frac{1}{3}$%. Communities with a population between 1,000 and 7,500 receive a level of funding based

on the formula: Grant % = 93 - 0.008 of the population. Community population is based on the most recently assessed population figures for the community.

Eligible Costs: Construction, engineering, land, legal, and some miscellaneous costs related to communal water and sanitary sewage works.

Construction costs include all costs that the municipality incurs to perform the work covered by the plans and specifications for the approved communal works project.

All parts of communal works, such as water supply intakes, water treatment and storage facilities, trunk feedermains, local distribution watermains, sanitary sewage treatment facilities, local sanitary collection sewers, outfall sewers, trunk sanitary sewers, sanitary sewage forcemains, service connections on public property, and associated pumping stations are eligible for funding assistance.

Construction costs are based on the lowest, responsible, public tender.

Engineering costs include the costs paid by the municipality to a consulting engineer for the design, construction supervision and the construction inspection of the approved communal works.

Land costs include the actual cost of land purchased for a treatment plant, water storage facility or pumping station.

Legal costs are the actual costs paid by the municipality for legal services providing they are related solely to the approved project and are not administrative or executive in nature.

All miscellaneous costs require supporting documentation.

Priority Review: All applications for grants are evaluated by the Ministry's Project Priority Evaluation Committee to determine the need for the works in terms of the correction of health and/or environmental problems and the accommodation of new residential growth.

Grading Procedures: Projects are assessed according to their effect on correcting health, environmental and growth related problems.

A grading of up to 400 points is assigned under each of the above criteria. The gradings for each are summed to establish a rating for each project. Projects with a rating of 200 or more are considered eligible for funding. Allocation of funds available are made to the projects with the highest scores.

Conditions: The municipality must pass and enact an enforced connection bylaw under Section 219 of the Municipal Act. This bylaw requires all property owners to connect to the system.

The works must conform to the requirements of an official plan.

1.3 Area Municipalities

Funding Level: As for large and small municipalities, except if the problem area is in a community with a population of no more than 7.500, the grant is 70% of the net eligible grant percent, as calculated under Section 1.2.

Eligible Costs: As for large and small municipalities.

Priority Review: As for large and small municipalities.

Grading Procedures: As for large and small municipalities.

Conditions: Award of grant is contingent upon the regional municipality paying 30% of the cost.

The community is well defined as a separate entity with respect to servicing requirements.

2. RURAL WATER PIPELINE EXTENSIONS

All municipalities may apply for funding assistance for water pipeline extensions outside of urban boundaries in accordance with the following:

Funding Level: $33\frac{1}{3}\%$ of the eligible costs after deduction of federal or other grants.

Eligible Costs: Only minimum systems consisting of small diameter watermains that serve only farm and residential uses are eligible for funding.

Construction, engineering, land, legal, and some miscellaneous costs related to water pipeline extensions and related booster pumping stations.

Construction, engineering, land, legal, and miscellaneous costs are as outlined in Section 1.2 (Small Municipalities).

Priority Review: All applications for grants are evaluated by the Ministry's Project Priority Evaluation Committee to determine the need for the works in terms of the correction of health and/or environmental problems.

Conditions: Each project is subject to approval by the Ministries of Agriculture and Food, and Municipal Affairs.

The design of the systems must not provide for fire protection or irrigation systems.

3. PRIVATE SYSTEMS

In small communities, currently serviced by private wells and septic tanks, individual homeowners may be eligible for grants for renewal or replacement of faulty systems. Trunk lines and treatment works for trailer parks are eligible if the parks are an integral part of the problem area.

Funding Level: $33\frac{1}{3}\%$ to 85% of the eligible costs after deduction of federal or other grants.

4. ACCELERATED CORRECTION OF SEPTIC TANK PROBLEMS IN URBAN AREAS

Municipalities with populations greater than 5,000 may apply for funding assistance to accelerate an existing program for the installation of sanitary sewers in urban areas currently serviced by malfunctioning septic systems in accordance with the following:

Funding Level: 50% of the eligible costs after deduction of federal or other grants.

II. LIFELINES PROGRAM

All municipalities may apply for funding assistance for pollution control planning studies; and the study of and rehabilitation of existing watermains and sanitary sewers in accordance with the following:

<u>Funding Level</u>: 50% to 85% of the eligible costs to complete a "Pollution Control Planning Study" to assist in the development of a water pollution control plan for a defined urban or rural area. Such studies will outline the nature, cause, and extent of pollution problems, propose alternative remedial measures, and recommend an implementation program.

50% to 85% of the eligible costs to complete a "Needs Study" which provides an inventory of the existing facilities and a plan of action for a rehabilitation program.

Funding level is based on the population of the community where the problem area exists. Communities with a population of 1,000 or less receive the maximum grant of 85% and communities with a population greater than 1,000 receive a level of funding based on the formula: grant % = 93 - 0.008 of the population, with a minimum funding level being 50%. Community population is based on the most recently assessed population figures for the community.

$33\frac{1}{3}\%$ of the eligible costs to carry out the physical rehabilitation, as recommended in the "Needs Study".

All costs are "net" after deduction of federal or other grants.

III. PROGRAM BUDGETS

The Direct Grant Program budget has increased in recent years. For example, the total payments to municipalities have increased from $102 million in 1986/87 to $182 million in 1989/90.

In the current fiscal year (1990/91), the transfer payment is $172 million, which includes provincial transfer payments, Direct Grants, and LifeLines.

The above amount is comprised of approximately $140 million for Direct Grants, $15 million for LifeLines, and $17 million for provincial transfer payments.

Provincial projects under construction have an additional budget of approximately $70 million this year.

IV. LOOKING AHEAD

Plans to establish a new Crown Corporation and to transfer provincial funding for sewage and water facilities were announced in this April's budget by the Treasurer. The new corporation, once established

by legislation, expected this fall, will assume all current provincial funding commitments and take over operations of all facilities now owned and/or operated by the Ministry of the Environment.

In the meantime, municipalities should continue to apply to the Ministry for projects considered eligible for assistance under existing grant assistance policies.

G. Mierzynski, P. Eng.

August 30, 1990

WASTE REDUCTION, PACKAGING, BIODEGRADABLES, COMPOSTING AND CHANGING LIFE STYLES

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WASTE REDUCTION, PACKAGING, BIODEGRADABLES, COMPOSTING AND CHANGING LIFE STYLES

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Over the past five to ten years, concern in North America over the management of our society's wastes has risen to sufficiently high levels that we are actually starting to do something about the problem. Unfortunately, there is often considerable disagreement as to what the best approach is to "solving" the municipal solid waste (MSW) problem. Recycling, incineration, composting, and degradability are all examples of techniques that have been introduced (or at least proposed) at one time or another, as a solution to some aspect of the MSW problem. Of all the components of MSW, plastics have been the subject of perhaps the greatest amount of debate, particularly plastics used in packaging. In this paper, I will focus in on the debate over the disposal of plastic packaging wastes as a means of illustrating the broader issues relating to MSW.

When discussing the management of any component of MSW it is essential to consider three factors :

1. what contribution does that component make to the overall total ?
2. how can management of that component be integrated with management of other components ?
3. what is the impact of changes in usage of one component (e.g.plastics) on the usage of other components (e.g. glass, metals) ?

Table 1 shows typical data for the make up of MSW. With respect to plastics, what is particularly evident from this table is that all plastics represent less than 10% of the total weight. While the volume percentage is of course higher, it is still estimated to be only about 15% when compacted in landfill. In setting our priorities with respect to the total MSW problem, it is clear that paper (at about 40%) and yard and food wastes (at about 25%) are the components that need greatest attention. Solutions to the plastics component have, therefore, not only a lower impact on the total problem but more importantly, must not interfere with the solutions to these higher priority components.

The public debate over managing the plastics component of

TABLE 1

MATERIALS DISCARDED INTO THE MUNICIPAL WASTE STREAM*
(in millions of tons and percent of total tonnage)

Materials	1970 tons	1970 %	1984 tons	1984 %	2000 tons	2000 %
Paper & Paperboard	36.5	33.1	49.4	37.1	65.1	41.0
Glass	12.5	11.3	12.9	9.7	12.1	7.6
Metals	13.5	12.2	12.8	9.6	14.3	9.0
Plastics	**3.0**	**2.7**	**9.6**	**7.2**	**15.5**	**9.8**
Rubber & Leather	3.0	2.7	3.3	2.5	3.8	2.4
Textiles	2.2	2.0	2.8	2.1	3.5	2.2
Wood	4.0	3.6	5.1	3.8	6.1	3.8
Other	—	0.1	0.1	0.1	0.1	0.1
Food Wastes	12.7	11.5	10.8	8.1	10.8	6.8
Yard Wastes	21.0	19.0	2.8	17.9	24.4	15.3
Miscellaneous Inorganic Wastes	1.8	1.6	2.4	1.8	3.1	2.0
TOTAL	110.3	100.0	133.0	100.0	158.8	100.0

* Discards after materials recovery has taken place, and before energy recovery.

Source: Franklin Associates

TABLE 2

PERCENTAGE OF LITTER BY BASIC MATERIAL

FOR URBAN RESIDENTIAL, COMMERCIAL, PUBLIC FACILITY STREET FRONTAGES

	Primary Material				
	Paper	Plastic	Metal	Glass	Other
Convenience Products (deliberate litter)					
Beer/Soft Drink Containers	-	4.1%	34.5%	61.4%	-
Juice, Wine, Liquor Containers	15.4%	30.8%	23.1%	30.4%	-
Bottle Caps	-	-	100.0%	-	-
Pull Tabs	-	-	100.0%	-	-
Carriers, Cartons, Labels, etc.	36.2%	59.6%	4.3%	-	-
Cups, Lids, Straws	30.0%	69.9%	-	-	-
Candy, Gum, Snacks, etc.	44.2%	36.2%	19.6%	-	-
Other Take-Out Food Packaging	39.7%	25.8%	34.4%	-	-
Cigarette, Matches, Tobacco Pckg.	2.2%	18.9%	12.7%	-	66.2%*
Napkins, Tissue, Bags, Utensils	83.3%	15.6%	1.2%	-	-
Toiletries, Cloth., Toys, Recreat.	42.9%	54.5%	2.6%	-	-
Other Products/Packaging (accidental litter)					
Newspapers, Mag., Books	100.0%	-	-	-	-
Advertising	100.0%	-	-	-	-
Home Food Packaging, Remnants	41.2%	13.5%	10.9%	0.8%	33.6%**
Veh. Supplies, Debris	24.0%	50.0%	17.3%	8.7%	-
Construct. Mat'l, Debris	74.6%	10.8%	14.6%	-	-
Misc. Paper, Plastic, Metal, Other	64.3%	29.4%	5.3%	0.7%	0.4%†

*(foil/plastic) ** (bones/peels) † (fabric, organic)

Notes:
(1) Paper category includes wood, corrugated cardboard, etc.
(2) Metal category includes aluminum foil which contains steel
(3) Percentages are by item count.
(4) Based on sample of 5139 items from California 1985 survey performed for the California Waste Management Board

Source: American Litter: 1986, Daniel Syrek

MSW has been well out of proportion to its real relative importance. This is due, however, to its real contribution to another aspect of waste management - litter. Table 2 shows data on the make-up of litter, by material of manufacture for different products. Plastics are the material of choice for the majority of these products. Beach sweep data confirms these numbers and has shown that seven of the top ten litter items (by numbers) are made of plastic. Litter may represent only a small fraction of the total waste that we produce, but it is highly visible. It is this visibility that has led to the focus on plastics in waste - correctly so in the case of litter but with much less validity in the case of MSW.

Having considered the contribution that plastics make to the waste stream, how then can the management of this component be integrated into the overall management scheme. Given the relative importance of paper and food/yard wastes it should not be surprising that recycling programs and, more recently, composting programs have received considerable attention. Ontario's blue box recycling program has been tremendously successful in collecting the newspaper, glass and metal components of household MSW - it has had less success in finding markets for these collected materials. Plastics have been accepted in blue box programs only to a limited degree for this very reason. The key to improving the amount of plastics that are recycled lies in the development of economically viable markets for the types of mixtures of plastics encountered in programs such as the blue box program. Plastics can be separated into the different types of resins and re-used (as is done for plastic pop bottles), they can be re-used as comingled resins for items such as plastic lumber or they can be processed into value added resin mixtures for re-use. The low price of the virgin resins with which recycled resins must compete makes recycling plastics a greater challenge than ,say, recycling aluminum. The Ontario Centre for Materials Research, one of the provincial Centres of Excellence supported by the Ontario Technology Fund, is funding research at several Ontario universities to provide a knowledge base for the necessary technology. Industry groups, such as the Environment and Plastics Industry Council are likewise backing work in this area. It is important to remember, however, that adding plastics to a comprehensive recycling program must be done in a manner that does not interfere with the collection/segregation of other more significant contributers to the total waste stream.

Composting, while of obvious value for organic food wastes, has little relevance to the disposal of conventional plastics which are essentially inert to biodegradation. A tremendous controversy has arisen, however, over the introduction of plastics that are designed to biodegrade. Deferring for the moment the issue of the role of these plastics in landfills, it is clear that a truly biodegradable plastic could be readily composted. The technology for biodegradable plastics is at a very early stage currently and it is perhaps safest to say that while this holds promise, it is not a solution to our immediate

problems. It does raise an important issue that is relevant not only to plastics, but also to paper and other products - namely additives. The use of pigments, dyes, filler materials, etc. must be either reduced or altered to ensure that only non-toxic products are used. Whether plastic or paper, and whether composting, landfilling or even incinerating, the disposal of an item implies the safe disposal of all of its constituents.

As mentioned above, the whole issue of degradability of plastics as a waste management tool has generated a great deal of confusion. There are two forms of degradability under consideration : biodegradability (degradation under the action of micro-organisms) and photodegradability (degradation under the action of sunlight). Photodegradability has no role to play in either composting or landfilling since buried materials obviously see no sunlight. Photodegradability is, however, being utilized for its intended fuction - litter control. It is not intended as a means of stopping litter, but rather minimizing the impact of litter once it has occurred. Much like the rationale for seatbelts in automobiles, it recognizes that despite education, fines etc. "accidents" are going to happen and that products must be built to minimize the consequences of such accidents. In terms of the total waste problem, litter is a small fraction as mentioned earlier. From that perspective, photodegradability is a minor issue. However, in terms of visibility of plastic waste, and thus in terms of reducing what amounts to obvious disrespect or abuse of the environment, any form of litter control assumes a much greater importance.

Biodegradability of plastics has been touted as a means of making plastics more compatible with both composting (as discussed above) and with landfilling. Unfortunately, recent studies on landfills suggest that degradation of anything - food, paper, plastic - is slight in a modern sanitary landfill. While this would seem to demonstrate that biodegradable plastics again have little to contribute to todays solid waste management, the whole role of landfills must be examined before that conclusion can be reached. The current situation of slightly bio-active landfills is clearly undesireable. If we act to remove all biodegradable materials from landfills and to compost them, then landfills will become the repository of inert materials only. Most conventional plastics fit that description and would thus be acceptable for landfilling. Truly biodegradable plastics would be diverted to the composting stream. An alternative to this scheme would be to operate our landfills as bioreactors - as yet only demonstrated in laboratory/pilot trials - in which case conventional plastics would be unacceptable for landfilling, with only biodegradable plastics being suitable. Once again, the choices that we make for solutions to the major components in the MSW stream will influence the choices made in our management of plastics waste.

The final waste management tool to be discussed here with respect to plastics is incineration. On their own, plastics can

be safely incinerated in modern high temperature incinerators. Given that their energy content is, kilogram for kilogram, virtually equivalent to that of oil, they are an excellent fuel for incinerators. Such arguments skirt the broader issue of whether incineration is at all desireable when compared to a recycling/composting option for example. My preference would be to emphasize the latter while recognizing that in those circumstances where incineration, ideally with cogeneration of energy, is necessary, that plastics are an acceptable fuel material. Public acceptance in North America of the safety of incineration in general is sufficiently low that its future is difficult to predict.

In the title to this paper two topics were listed that have not yet been mentioned : waste reduction and changing life styles. All of the foregoing discussion has presumed that the issue is how to dispose of waste. There is a more fundamental question that can be asked - namely how to reduce the generation of waste in the first place. There is a simple equation first stated by Dr.J.Guillet of the Univ. of Toronto :

Production = Garbage + Litter

By reducing the left hand side we necessarily reduce the problems associated with all aspects of the right hand side. We must be careful not to confuse absolute reduction with the more common reduction of one material at the expense of an increase in another. Many attempts to reduce materials use fall into this trap.For example, replacing plastic bags with paper increases the volume and weight of waste due to the bags by a factor of nearly eightfold. If the ultimate fate of the bags is a landfill, neither paper nor plastic will degrade to any meaningful extent. The plastic bag is the better choice - a comment that I'm sure will find much criticism. An even better choice would be a re-useable bag but this introduces the most difficult choice of all - that of changing our lifestyles. The above survey of waste management techniques for plastics illustrates that there is range of options available to us. By choosing the combination of techniques best suited to a particular mixture of waste products we can more intelligently manage our waste than we do now. Whether we are, as a society, ready to address the more fundamental problem of reducing consumption is an entirely different matter.

ANTHONY E. REDPATH

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PRACTICAL APPLICATIONS OF THE NEW MISA MUNICIPAL SEWER USE BY-LAW

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PRACTICAL APPLICATIONS OF THE NEW MISA MUNICIPAL SEWER USE BY-LAW

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ABSTRACT:

The Ministry of the Environment has stated that the ultimate goal of the Municipal and Industrial Strategy for Abatement (MISA) is the virtual elimination of toxic substances from discharges to the Province's waterways. A major component in this strategy is the new MISA model sewer use by-law, which must be implemented by all Ontario municipalities. Demonstration projects are currently underway in five municipalities. This paper discusses the implications for the municipalities and industries, and highlights some of the procedures required for implementation.

BACKGROUND

The Ministry of the Environment has stated that the ultimate goal of MISA (Municipal and Industrial Strategy for Abatement) is the virtual elimination of toxic substances from discharges to the Province's waterways. The program is being developed in a dichotomous manner with two particular strategies being implemented concurrently. The first has been to regulate the effluent generated by the majority of companies operating within eight well defined industrial sectors and discharging directly to waterbodies: pulp and paper;

petroleum refining; organic chemicals; inorganic chemicals; iron and steel; mineral industry; metal casting and electric power generation. Work on this part of the strategy is well underway and is expected to be completely in place by the end of 1991.

The second part of the strategy, and the subject of today's discussion is the implementation of the new MISA model sewer use by-law. This will impact on all industries discharging into municipal sewers who will now have to meet stringent discharge requirements. To facilitate the implementation of the new by-law, the MOE is currently funding five demonstration studies across Ontario. These studies will provide a modus operandi, or a blueprint for the implementation of the sewer use by-law in all communities across Ontario, which is projected to take place by the middle to end of 1992. The municipalities involved are Gananoque, Hamilton, Cobourg, Thunder Bay and Ingersoll. These municipalities were selected on the basis of geographic location, size, type of treatment and willingness to participate in the program.

Proctor & Redfern is actively involved in two of the demonstration studies, namely, Hamilton and Gananoque. After initial teething problems, the programs are now functioning well and are more than 75% completed, with completion expected by the end of 1990.

THE MUNICIPAL MISA PROGRAMME AND ITS IMPLICATIONS

It has been our experience that just the mention of the new MISA municipal sewer-use by-law strikes fear in the hearts of many municipal engineers and employees. The whole approach and philosophy to implementing such a program appears enormous and complex.

I hope this paper today will go a long way to unraveling the mysteries of this program. When the subject of a municipal sewer use by-law is raised, two questions are invariably asked:

- How am I going to implement this and what resources are required?

- Will it result in industries leaving town when I get tough?

The implementation procedures will be dealt with in more detail later. As far as the impact on industries is concerned it is evident that the new legislation has given the environmental laws teeth. Industries will no longer be allowed any leeway and therefore, excuses will not be accepted. Those which cannot meet the limits of the new by-law will soon face the following choices:

- to implement process modifications

- to implement appropriate pre-treatment

- to negotiate a surcharge with the Municipal authority

- to close down the plant

The cold hard facts are that the cost of doing business in Ontario just went up. Fortunately, most industries will be able to accommodate the new requirements, albeit at additional expense which will be passed on to the consumer. For some industries with

outdated processes or equipment, the impacts could be very severe, however, this is the natural outcome of society's wish to reduce environmental degradation. Generally speaking, any viable industry will remain and respond to pressure. Some, however, will threaten to leave, and these are probably borderline and perhaps best done without. It is our experience that many industries can benefit from assistance from a qualified consulting engineer to explore the opportunities for process modification such as flow separation and reduction, which can provide cost-effective solutions.

From the municipal perspective, the authority which owns and operates the sewage treatment plant is responsible for the quality of its effluent. What is tolerable in terms of upstream discharges is a function of the individual municipality. In the event of poor effluent quality, the Ministry of Environment will challenge the municipality, and the onus is then on the municipality to improve its effluent by enforcing the sewer-use by-law. Consequently, due caution must be exercised when establishing the effluent requirements from various contributing industries.

A most important factor is that the new sewage use by-law renders all existing agreements null and void at the time of implementation. Therefore, each industry will have to renegotiate existing discharge agreements. This can be particularly beneficial if the growth of the town has exceeded expectations and there is currently an industry with very lenient requirements taking up valuable sewage treatment plant capacity.

IMPLEMENTATION PROCEDURES

In addition to the five demonstration studies which are currently underway, many municipalities are already proceeding with implementation of the program. It is important to recognize that an early start to the survey is the key to a successful program. This provides the opportunity to:

- introduce the program in an orderly and well-defined manner

- gain public confidence and co-operation by approaching the system slowly

- allow industries to budget and plan for the impending sewer use by-law and not be threatened by its rapid introduction

- address key political issues in a timely manner, such as industries threatening to move to other locations

- allow the spread of implementation costs over a longer period

The implementation of the new Sewer Use By-law consists of ten steps:

- Public Participation Program
- Identify Legal Authority required to implement Program
- Industrial Waste Survey
- Waste Sampling and Technical Analyses (STP/Collection System)

- Develop Sampling Strategy (Industrial Dischargers)
- Develop Local Limits
- Develop Enforcement Strategy
- Develop Sewer Use By-Law
- Effluent Discharge Limits
- Evaluate Resource Requirements

However, our experience has been that the following steps are the most critical.

- An industrial waste survey of all non-residential sewer users (this includes all commercial and institutional users)

- Sampling programs of the influent and effluent to the sewage treatment plants and of the effluent from the Significant Industrial Dischargers (SID's)

- Setting local by-law limits based on the type of industrial discharges, influent characteristics, the existing sewage treatment facility and the receiving water body size and quality.

Waste Survey

The most important and time consuming step in all the Demonstration Studies has been the waste survey. Typically, the larger a community, the more time consuming and labour intensive the operation. The other steps are not as complex, but can become time consuming depending on the findings of the survey. The success of any program is clearly

linked to the speed and completeness of such a survey and consequently significant effort should be applied at this stage of the project development.

A survey typically consists of three parts:

- A detailed, or long form questionnaire, to all SIDs
- A short form questionnaire to all non-residential, non-SID sewer users
- A waste survey of all sites storing chemicals

The time required for the survey can vary from 4 months as in the case of Gananoque, a town of 4,000 people, to upwards of 12 months for larger communities, depending on their industrial make-up. Generally it is found that the number of industries requiring short forms is about ten times the number requiring the long forms. For example, Gananoque has 14 SIDs and 130 non-residential sewer users, while Thunder Bay has approximately 40 SIDs and 350 non-residential sewer users. To expedite the data gathering, personal visits are recommended for all the SIDs and for many of the other non-residential users.

A typical waste survey consists of several steps.

- Identify and classify all non-residential dischargers
- Identify the SIDs

- Prepare mailing lists and distribute forms

- Follow-up non-responding parties with calls and/or visits depending on the complexity of the industry

- Develop a computerized database

- Interpret the results

The survey should be proceeded by a public information program which initially should include, in each mailing, a covering letter explaining the obligation of all industries to participate and an information package on the scope of the MISA program. At a later stage, a public information session for all SIDs can be convened, if required, but this is not essential in the initial stages.

It has been our experience that considerable effort is required, and full time staff should be allocated.

In one Ontario municipality, a city of 80,000 people, which is about to commence a waste survey in advance of the ultimate introduction of the Sewer Use By-law, six people will be employed full time to complete this job. Gananoque currently uses 1.5 people full time.

Sampling Program

For the municipality, this consists of the analysis of composite influent and effluent samples for the treatment facility over a 7 day period. It is also usual to analyze samples of residential sewage flows and also of any sludges produced at the plant. Complete analysis is required for all the parameters indicated in the MISA By-law. This will normally require assistance from a specially qualified laboratory facility.

For each significant industrial discharger, similar representative samples must be collected and analyzed. Such a program should take cognizance of production lines, product variation and annual cycles. This would normally be the responsbility of the industry, however, the municipality may wish to participate in or supervise this work.

Setting Local Limits

Based on the ability of the existing treatment facility to handle the scope of the incoming waste as assessed by MOE, local by-law limits are established. This involves the minimizing of the impact of the contributing industries, by forcing them to reduce their discharges to levels equal to or lower than the sewer use by-law, such that treatment efficiency at the STP is not affected. In some cases the municipality will be required to upgrade their treatment facility.

ONGOING ENFORCEMENT

Once the new by-law is in place, the municipality will be responsible for enforcement. Special equipment will be required to monitor discharges. This would include, as a minimum, sampling and analytical equipment, vehicles, and laboratory facilities. Some analyses could be done locally, while more complex work would have to be contracted to a specialist laboratory. For larger municipalities, it may be economically justifiable to provide laboratory facilities capable of undertaking all the MISA analyses. There is no urgent need for all this equipment in the initial stages, however, early commencement can allow for these items to be purchased on a gradual basis, as opposed to one lump sum later.

SUMMARY

The Ministry of Environment has indicated that the initial stages of the new MISA sewer use by-law implementation will occur towards the end of 1991. At that time municipalities will be asked to submit a draft proposal on how they intend to implement the program, as well as a projected budget. After a review period of approximately six months, the proposals will be approved on a case by case basis and the program will commence. The funding is expected to be on the same basis as current MOE grants, which vary based on the size of the community. At this point there is no indication of the timeframe allowed for implementation, but as mentioned earlier, it can be a lengthy process.

It has been our experience to date that the new sewer use by-law is an effective tool in controlling industrial discharges, although it places a greater responsibility on the municipality. The province-wide nature of the law basically forces all industries to be treated in an identical manner, and therefore obligates them to clean up their act.

A municipality faced with this new by-law has basically four choices.

- It can force the industry to meet the sewer use by-law exactly as promulgated.
- It can allow the industry to negotiate a discharge agreement whereby a surcharge is allowable for a fee, provided that there is sufficient capacity to treat the waste at the plant.
- The industry can be forced to pay part of the plant operating cost as well as a contribution to future capital expenditures.
- If immediate plant upgrading is needed, the industry can be forced to contribute to the capital and operating costs based on flow and loads to the plant.

In general, the municipality has a lot of options open to it when implementing the sewer use by-law, and therefore, they should not be scared of this impending legislation. We have found that while industries tend to posture a lot, very few will actually fold their tent and leave. This is especially the case if the reason for the departure is seen as an inability or lack of responsibility towards the environment.

Thank you for your attention and good luck.

90 09 08

BLUE BOX RECYCLING

Mel Fisher
Town Engineer
Dryden, Ontario

BLUE BOX RECYCLING

Presented by Mel Fisher, Chairman
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ABSTRACT

Ontario leads the world in this approach to recycling due to very active promotion by the Ministry of the Environment, assisted by industry, especially the pop industry. This paper recounts the experience of one system serving 25 municipalities in Northwest Ontario. It suggests that due to the success of this and other promotions, supply of many of the recycled commodities has outstripped demand, resulting in poor economics, at least on the short term. It suggests that recycling be looked at as a service and as such not expected to be profitable, and as the people are very supportive of it municipalities ought to participate. It points out that the whole field of solid waste management is evolving and blue box recycling is by no means the last word.

DISCOURSE

Blue Box recycling is a low-tech approach under which the householder separates certain material from their garbage, and puts it out for separate collection to be processed into a usable commodity. This approach has been heavily promoted by the Ministry of the Environment and Ontario now leads the world in this technology. The legislation which allowed the use of aluminum cans in Ontario also required the pop industry to take initia-

tives which would see meaningful recycling going on in all parts of the province by November, 1988. To this end, they created OMMRI, a corporation set up to promote recycling. Nobody north of about Barrie would even talk to OMMRI. Dryden was setting up a voluntary depot type of recycling program, and had applied for assistance. Since we had shown that much interest, OMMRI approached us with a proposition in May, 1988. If we would go into a full-scale class 1 blue box program by November, that would mean at least somebody in the north would be recycling and satisfy the terms of the legislation. In return, they would provide all the capital, marketing, promotion, and engineering needed to get the system running. They would locate a processing facility in Dryden sized for all of NWO west of Thunder Bay, and similarly assist any other area municipalities who wanted to be in so they could collect material and deliver it to the Dryden plant. Since we felt we would be pressured or legislated into the blue box program eventually, we decided to go while the terms were quite attractive. Dryden started collecting newspaper, glass, cans, and plastic pop bottles on December 8, 1988, which was close enough to the deadline to satisfy the legislation. After some deliberation, 24 municipalities decided to join us. That is all the municipalities in the Kenora-Rainy River districts except Atikokan and Pickle Lake.

It is difficult to get two municipalities to agree on anything, and to have 25 actually join together in such a venture is by itself a major political achievement. An Association was legally incorporated, with a board of directors elected by the

municipalities, and whose operation is underwritten by the municipalities in accordance with a contractually-committed formula. Dryden's operation was turned over to the Association, and on March 5, 1990 the association began collecting, processing, and marketing recyclables from all 25 municipalities.

I am chairman of the Board of the Association, and as we do not have a hired manager have been managing the Board's operation along with my real job as Town Engineer of Dryden. Not single-handedly, of course; the board itself has been very active, and Tom McConnell of Dryden's Engineering staff has been seconded to the association for much of his time. We have recently hired an employee on a one-year contract to take care of the paperwork, handle the press, do studies to obtain some hard operation data, and troubleshoot weaknesses in our operation; we have not made any decisions on the long-term management of the operation after this contract runs out.

Our territory consists of populated areas separated by large tracts of vacant country and our operation is divided into four "nodes", each a discreet populated area. Each "node" has its own committee, with a representative of each municipality and its own representation on our board. We have a blue box in each household, and 90 gallon blue bins - the kind used for semi-automated garbage collection systems - available for apartment buildings, businesses, and at Collection Depots. We have an automated collection vehicle capable of self-dumping the bins operated by a Contractor located in each node. The contractors collect blue boxes curbside into the vehicle in all the

municipalities which have curbside garbage collection. In those municipalities which do not have curbside garbage collection, mostly rural or scattered, the people empty their blue boxes into the bins at the nearest depot, often at their landfill or dump, and the contractor empties the bins into his vehicle. When the vehicle is full, it is driven to the Processing Plant at Dryden. Other municipalities are various directions from Dryden, like spokes on a wheel, and distances are quite large, up to two and a half hours drive away.

Newspaper is kept separate, and everything else mixed together, 'commingled' in the bins and on the trucks, and dumped into a newspaper pile and a commingle pile at the plant. There are two processing lines in the plant. On the baling line, newspaper is hand-sorted over a sorting table onto a conveyer which feeds the baler through a fluffer. The baler is a low-production, hand-tie model appropriate to our small population - we only serve about 30 000 people - and makes excellent quality, very dense one-ton bales. The commingle is run over a sorting conveyer from which usable glass is hand-picked into large, 1 ton bags, and foreign material is hand-picked to a bin, then over a fine screen which takes out the finely broken glass, then up a conveyer with a magnetic head pulley which pulls out the steel food cans and drops them into a large wheeled cart. A second screen then separates the aluminum pop cans from the plastic pop bottles by size, dropping each into separate wheeled carts. When full, the carts are dumped by a mechanical dumper onto the baler feed conveyer, on which they get a second visual check to pull

out the small quantities of material which was missorted by the mechanical sorting line. They are then baled as well, and it is amazing how a pile of pop cans can be pressed together so hard that they stay together in a large, 3 foot by 3 foot by 5 foot bale.

One of our main liabilities is our long distance to markets, and as we pay the freight it is crucial that we do not have a load rejected after investing all that freight money. Quality of product is therefore doubly important to us and much of our management attention is directed to ensuring top quality.

The people are squarely behind the program. We do not have actual counts which would allow us to quote participation rates with authority, however, we believe we are getting 90% plus. We are greatly aided in our quest for quality in that our people do an exceptionally good job of washing out containers, so that we have no 'garbage' smell at our depot, and none of the insect and vector problems others report. Our only complaint is an excess of enthusiasm; people put in materials which we are not able to market at this time, such as assorted plastic containers, stacks of paper grocery bags. These have to be hand picked out, and end up in Dryden's landfill.

Our product mix is quite different from that in other operations in old Ontario. About one-third of our total tonnage is newsprint, while two-thirds news is more typical elsewhere. This is partly because our newspapers are thinner - the biggest being the Winnipeg Free Press. We did a check on the tonnage of newspaper being shipped into Dryden, and found that we only get

about half of it, and we suspect this would apply to the other towns as well. We suppose the rest is burned, as wood-burning appliances are in common use in our wilderness area. On the other hand, the proportion of pop containers and especially the large plastic pop bottles is much higher, perhaps 3 or more times as high as is typical elsewhere. We suppose this might be because less returnable bottles are used here, or maybe we just drink a lot of pop. This product mix is very much to our advantage, as there is a little money to be made in pop containers, and a lot to be lost in newsprint in today's market conditions.

We have been able to find markets for all our commodities, and OMMRI have been helpful in this as they promised. However, prices are too low in some cases. Aluminum is readily recycled into new aluminum at much less cost than virgin material, and this makes it a high-value material. The steel and glass industries are anxious to maintain their share of the container business, and have programs to buy back their product. We have been sending our steel to Algoma in Sault Ste. Marie, and with the freight subsidy the tin-plate industry provide we can recover all cost and it pays its way. There is only one glass company left in Canada, Consumers glass. I suspect that the price they pay for recycle is as much or more than virgin material, however, they set very high quality standards - it has to be hand sorted, and recognizably part of a bottle or jar - and that is expensive. Further, they demand shipment loose in end dump trucks which eliminates any chance of a backhaul arrangement to get a decent freight rate. We paid $91 a ton to ship our first load, for

which we got $60 a ton, and of course that doesn't address the cost of hand sorting. We are pursuing a more attractive market in Minnesota: if that doesn't work out, we will have to seriously question continued collection of glass.

Newspaper is another story. There is a world glut of old newspaper. Old news is an established, free market and in this situation, supply having outstripped demand, the price has gone to less than zero in much of the world. We have been able to sell all our newspaper, however, the price does not cover the sorting cost. I believe that the real value of the product in the wood and pulping costs the mill avoids is greater than our cost to collect, sort, and ship it, and a price between these two values is necessary if we are to enjoy a good, long-term supplier-customer relationship, profitable to both. The industry is offering a good price in relationship to today's market, but nowhere near our costs. I believe that is shortsighted on the part of the industry. The people are not prepared to continue to cut down trees and bury them in landfills, and unless the industry gets onside and adopts a more cooperative, pro-active stance, their own future in endangered - newspapers can be replaced by computer screens.

One of our main problems has been the rapid evolution of the whole business. Before a system can be implemented, it is obsolete. By the time our plant was in service, the rules had changed so that glass had to be hand colour sorted, and we had to modify the plant to provide for this. Now we learn that aluminum and glass are supposed to be stored indoors, so we do not have

adequate storage space. Our volumes are higher than anticipated or than we experienced in Dryden alone, presumably because there is a swing to plastic pop bottles, so our collection system in inappropriate. We are finding as many as 25 of the 90 gallon bins are needed at a single depot and perhaps we should be using a higher capacity depot system such as front-load bins or roll-offs.

I do not think we are adequately handling our garbage. Test work being done in the U.S. indicates that in a properly run-fully engineered landfill where the material is packed tight enough to exclude air and covered well enough to exclude water the garbage does not break down or biodegrade - it just sits there. Readable newspapers and recognizable vegetables have been exhumed after decades in a landfill. This means that landfills do not dispose of garbage, they merely store it. I believe that the day will come when the old landfills will be dug up in order to properly and finally dispose of the garbage, and that is not a legacy we should leave our grandchildren, and landfills should therefore be regarded as a last resort only. Everything which can be used or disposed of in a more acceptable manner should be, and recycling programs should be expanded to include as many materials as possible.

I think we have to stop looking at recycling as a business venture. Rather, I think we have to look at Solid Waste Management as a system, providing a service. Recycling is part of that system, and just as we would not expect a leachate collection system to pay for itself or turn a profit, we should not expect a

profit from recycling. The people are very supportive of recycling - they see it as something positive they can do to help save the planet, and as a 'right' thing to do. They are willing to pay what it costs, and it is after all their money. We are here to serve the people and to carry out their wishes, and I think those municipalities who are resisting the program on short-term economic considerations need to rethink their position, although it is evident that small, remote communities cannot afford to recycle in today's conditions.

On the subject of money, our experience is different from other systems. We experience very high freight costs to get our product to market, and very high collection costs because of the long hauls to Dryden. However, our good product mix with lots of aluminum and plastic helps offset this, and I believe we are doing as well as some larger systems as far as per capita subsidy is concerned. Our subsidy per ton of material diverted is very high because of the freight. We suggested our member municipalities budget $2 per capita per year, and we expect to be within that budget. Being in our first year, we are getting the maximum Ministry of Environment operating grant; without the Ministry operating grant, our deficit on operations would be closer to $7 per capita. Smaller municipalities would find that a heavy burden, and we have suggested to the Ministry that something will have to be done about freight costs and collection costs before other northern communities are likely to start recycling programs.

I also think that the blue box system is only a step, and other means of recycling such as processing the waste stream through a factory extracting resources will be part of the picture. Compostables ought to be so used, and combustibles which cannot be economically recycled or composted should be processed and used as fuel - after all, they will be displacing coal thereby helping conserve our fossil hydrocarbon resource.

To sum up, our experience has been basically positive. There are market problems, but I believe they are short term. Other technologies will come on, but I believe the blue box will be part of our waste management program well into the future. Landfill is rapidly becoming thought of as an unacceptable technology, and recycling will become more and more important. I believe all municipalities should be moving toward instituting a program, because that is what the people want, although remote northern communities are going to have difficulty because of freight costs. Finally, the whole solid waste management business is evolving so rapidly that we all must pay close attention to avoid being left behind.

SMALL BORE SEWERS: A DEMONSTRATION PROJECT

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Subject: Small Bore Sewers: A Demonstration Project

Introduction:

- What is Cost Effectiveness?
- What is a significant Cost Savings?

These are two questions which have been considered in the continuing review of current technology as it applies to sewage collection systems.

The following issues must be considered when determining the appropriateness of alternative technologies:

a. the practical application of engineering principles,
b. the best use of limited public funds,
c. the application of more specific specifications and design parameters, and
d. the use of modern technology and materials.

Sewage collection and treatment is a very costly and often an unaffordable social amenity in small rural communities. This is due to factors of scale, remoteness, and lower income levels in many of these communities. Conventional servicing programs are very costly, and frequently adequate sewage disposal is not available, or alternatively, require inordinately high levels of subsidization, from outside the community. This situation pertains generally to rural and northern areas in Ontario and Canada, as well as most parts of the world. We are in an age where affordability is a prime concern, and the public dollar is stretched to the limit to rehabilitate old systems using old technologies. Developing and applying new cost effective technologies and methods must be a high priority for those responsible for delivering public infrastructure.

Our initial project in the Town of Field has produced an effective product for considerably less than conventional sewerage. In Field, Ontario, 40% more is being serviced by the same dollar through the application of SBS technology. In cost comparison, conventional sewage collection costs 70% for the same length of serviced area.

There have been very few applications of local innovations in sewerage and sewage disposal methods in recent times. The commonly used method for community-wide application has been the "conventional" system. This system is characterized by interconnecting a series of manholes by standardized large diameter pipes with minimum flow velocities and relatively high design flows. These flows include a significant allowance for infiltration and high peaking factors. Typical of this system are 200 mm diameter pipes at minimum slopes of 0.3%, producing minimum scouring velocities of 0.6 to 1.0 metres per second with manholes at every 100 to 110 metres and at intersections. Typical cover is 2.0 to 2.6 metres depending upon the application.

The **S**mall **B**ore **S**ewer is a relatively new innovation in sewage collection. **SBS** was first installed in a few locations in Africa, where, presumably, the pressure for innovation was high. It has since been installed in numerous communities in other parts of Africa, Australia, and the U.S.A. Some existing systems in Australia have been operating effectively for over 25 years. We are aware of grinder systems, vacuum systems, and utilidor systems installed in various areas of Canada, but until recently there has been little or no application of SBS technology. The collection system provides primary treatment of sewage which will allow for segregation of suitable sludge for recycling into other byproducts (fertilizers, etc.). Periodic simple flushing of the system is recommended, and sludge removal from the tanks on a 3 to 5 year cycle has been suggested. The long term cost for maintenance of the system is comparable to conventional sewers over a 25 year design life.

SBS technology can be effectively applied to rural or fringe areas of major settlements, or in small isolated population centres throughout Canada and other parts of the world. Although it is compatible as tributary systems to conventional sewerage, it is not appropriate for use in downtown New York.

Local History of SBS:

As part of a study on the Cost-Effective Technology that we provided to the Ministry of the Environment in October of 1985, wé also provided a discussion of application and experiences with the systems in Australia, Africa, and in the United States. This overview included a description of the evolution of design criteria from initially no criteria (i.e. an interim solution to a rural community's sewerage problem) to a very comprehensive and conservative set of criteria set out in Australia as an aftermath of the recognition of the technology.

One interesting general conclusion of our study was that *"the existing SBS systems throughout the world have functioned well over their history to date, but that more current conservative design criteria have infringed upon the potential economic benefits that may be derived from a more practical design approach to the system."*

Recommendations in our Study:

One of the recommendations of the study was that the Ministry consider the application of Small Bore Sewers to a Demonstration Project in rural Ontario. This would provide a basis for the establishment of design criteria, taking into account in the design the climatic differences between Canada and other areas where the systems have been designed and installed. Based on this recommendation, the Ministry assigned a further feasibility study for the application of **SBS** technology to the Town of Field, near North Bay, Ontario. This study was completed in 1986, concluding that SBS could be applied.

Site Characteristics:

The Town of Field is characterized as being small (a few hundred in population), relatively isolated (approximately one hour north and west from North Bay) with a relatively low income base. The majority of the residents work with a seasonally operated lumber mill set in the heart of the community. From an infrastructure point of view, there has been a history in Field of well pollution, inadequate sewage disposal, infringement on separation standards for well and sewage disposal systems, and relatively poor land planning. More currently, the **MOE** has provided programs to re-establish water supply by deep well drilling

with deep casing and grouting. It is understood that the **MOE** has invested as much as $10,000 per well installed in the study area.

The existing sewage disposal systems in the study area consisted of pit privies, some holding tanks, some septic tanks with tile fields, and some direct discharge onto the ground surface. Certain sewage effluent passes over several owners' private property, and there was evidence of sewage being directed along roadside ditches and eventually outletting to the adjacent Pike River. The **MOE** has maintained an interest in protecting the major investment in the new wells in the study area.

The serviced area included thirty-seven houses. As mentioned earlier, the area was poorly planned. Some of the houses are infringing on the road allowances and there is an unstructured development pattern in the study area. Certain roadways are on private land and setbacks; side lot clearances have not been respected.

As previously mentioned, we had recommended that **SBS** could be installed in Field, and that certain of the attributes of the system (i.e. variable alignment, variable location, and shallow installation depths) would clearly be identified and utilized in this setting. A preliminary estimate of cost of conventional sewers verses SBS indicated that there was a potential net savings of up to 40% by utilizing **SBS** technology over conventional technology for the village of Field.

Design Considerations:

Based upon the experience in Australia, the United States, and Africa, we have evolved a completely innovative design approach for the Canadian environment. Many factors were taken into consideration in order to properly assess flows, flow criteria, peaking factors, outlet attenuation of flow in the clarifier tanks, the effect of pumped effluent, and the degree of treatment at the treatment location.

The field investigations included a detailed house by house survey of fixtures, population, individual household plumbing systems, existing disposal areas and methods, elevations, and potential options for routing of the mains and laterals. We also completed a geotechnical investigation in the study area for frost penetration in the roadway and along potential routing areas in order to assist us in the determination of the best possible location for the shallow bury system. This

geotechnical investigation also assisted in the assessment of the amount of frost protection that would be required to ensure proper functioning in severe winter conditions.

Once the data was collected and analyzed, the preliminary routing was selected, and suggested design criteria was provided to the Ministry of the Environment for consideration. After lengthy discussion and consideration, the Ministry accepted a modified approach to standard design criteria, and the preliminary design was completed. We used computers to provide the optimum system sizing, and to evaluate heat loss of the effluent in the system.

Public meetings were held in the community for familiarization purposes (with the technology) and for public input. Public analysis and comments on the field layout of the pre-engineering design served as part of our design process. The preliminary design was then tested, thermodynamically, by computer simulation to ensure that there would be no potential freezing of effluent in the mains during severe winter conditions. This analysis entailed the application of the localized weather conditions over varying ground conditions (moisture content), air and effluent temperatures, snow cover, wind conditions, and the application of a suitable period of depressed temperatures. This was the ultimate theoretical test process, and our design performance exceeded our expectations.

Materials and Specifications:

Small Bore Sewers are implicitly simple by nature, with relatively few appurtenances and shallow bury depths. This means that the considerations for materials, installation, and maintenance procedures vary significantly from conventional sewers. This also means the generation of new engineering details on such things as clean outs, private pump chambers, junction boxes, and standard trench sections (for a combination of uses).

For reasons of compatibility with a design criteria of "zero" infiltration in the mains, and apparent flexibility and ease of assembly, HDPE (high density polyethylene) was selected as the main material. The availability of heat-welded joints and long rolled lengths of materials made the HDPE even more desirable. There was a complete catalogue of special fittings, bends, couplers, adapters, and connectors

which made the HDPE ideal for SBS application.

Special Appurtenances:

One of the problems encountered in the design process was the adaptation of existing small diameter fittings to their intended use. Certain bends, couplers, and fittings are only available in certain sizes. We also wanted flush points to be compatible with the local fire department's equipment since municipal water was not available for future maintenance work. After lengthy review and research, it was decided that a 75 mm minimum diameter pipe was preferred. The larger diameter (hence more capacity) allowed for potential infilling on vacant lots, and also removed a potential odour problem identified with similar systems in the United States.

Installation Procedures:

Hand in hand with the selection of materials and the design of the system, was the direction for standard installation procedures. The suggested installation included above ground assembly, lowering the mains and connected laterals into the pre-excavated trenches, and connecting the system to the installed clarifier tanks and manholes/junction boxes. The contractor was required to select the installation length based upon his projected daily production in order that a minimum amount of trenching would be left open overnight. All pipes would be capped or connected securely, prior to the placement in the trenches.

The flexibility of HDPE pipe allows preassembly to be considered. Above ground assembly would also allow most of the manual work to be completed on the ground surface, therefore allowing the trenches to be narrow and more vertical. Surface to subsurface temperature differentials were reviewed during installation to ensure thermal expansion/contraction would not injure the piping network.

The minimum depth of bury of the main was 1.25 metres (approximately 4 feet) for the demonstration project. This allowed the contractor to approach the installation similar to underground utilities. The degree of skilled labour required for the assembly and installation was minimal. A narrow bucket rubber tired backhoe was primarily used for trenching. Pipes were welded prior to placement, and testing

procedures were completed prior to substantial backfilling. The integrity of the system to ensure "zero" infiltration was carefully monitored and tested prior to the acceptance by the engineer and client.

A television inspection of the system was carried on after construction. This inspection indicated that one joint in the entire 1400 metres had a partial collapse due to overheating at the time of assembly. The system had been operating for several winter months, flaw included, without a problem.

Conclusions:

We are looking forward to the completion of the installation of the second system currently under design in Maryland. With more performance history in place, the future looks bright for the use of this technology. If Small Bore Sewer Technology can survive and remain in its implicit simple form, vast cost savings can be achieved. This technology, like any other new innovative ideas, must overcome the "resistance to change" that is so prevalent in our society.

Our projects will be monitored for performance, and evaluated carefully by various Ministries and Departments, and ultimately the technology will be accepted as a true cost-effective solution to many severe problems in semi-urban, rural, and remote areas of the Province. We expect that the technology will continue to have expanded use across North America and in all parts of the World.

The capital cost savings achieved by the use of this technology is significant. We are predicting that once the technology has been utilized to a greater extent, and the construction industry becomes familiar with the efficiency and simplicity of the installation process, further savings in capital cost will be achieved beyond the amount realised in our Field, Ontario project.

Small Bore Sewers are a legitimate solution to major current problems in sewage collection for variable applications throughout Canada, the Canadian North, and across the world.

Prepared by,

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NEW WASTE MANAGEMENET INITIATIVES

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TOWARDS A BETTER MOUSETRAP

Practical Applications of Technology in Optimizing Waste Disposal Capacity

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ABSTRACT

Waste disposal capacity is a rapidly disappearing resource throughout North America. The volume of individual waste production continues to increase at a substantial rate. Combined with increasing population, this results in a substantial increase in the volume of waste materials which must be managed each year.

At the same time, there has been a significant decrease in the capacity to dispose of these waste materials. Landfill capacity for discarded materials is being depleted at a much faster rate than it is being created.

Recognizing both the limited availability of disposal capacity and the inherent value of many components of the waste stream, there has been an increasing focus in recent years on the 3R's, reduction, reuse and recycling. However, the benefits of these programs have not offset the need for additional disposal capacity and the capacity crisis in many municipalities.

This paper will review certain practices presently under development which will permit optimization of existing disposal capacity so that additional time is available to implement supplemental strategies for management of waste materials.

OUR CANS RUNNETH OVER

Volumes of waste production have increased dramatically over the past decade. In a recent publication[1], Pollution Probe estimated the weight of solid waste to be produced in Ontario during 1990 at between 12 million and 14 million tonnes. The publication also projected increasing waste production rates of

3 to 5 percent per year. USEPA[2] projects a slower rate of increase in waste production, but still anticipates a 10 percent increase in waste generation between 1988 and 2000.

Despite the development of alternate waste management strategies which reduce waste quantities or divert waste from landfills, land disposal is by far the most prevalent management practice. Some 73% of U.S. waste goes directly to landfill (1). In Ontario, the proportion of waste landfilled is substantially higher.

At the same time as waste generation rates are escalating, existing waste disposal capacity is being consumed at a greater rate than new capacity is being created. It is therefore essential that waste managers seek every opportunity to divert materials from disposal sites and maximize the use of remaining capacity.

Two significant options for maximizing the capacity of existing landfill units are the diversion of yard waste to compost facilities and the use of alternatives to soil for daily cover. Both practices are becoming increasingly prevalent. The following case studies typify a number of such projects which are currently underway throughout the waste services industry.

YARD WASTE COMPOSTING

USEPA[1] estimates that yard wastes comprise some 17.6 percent by weight of the total municipal solid waste produced in the U.S. This waste is characterized as being biodegradable and having relatively low pollution potential. Recognizing the burden it places on waste disposal capacity, several U.S. states have enacted regulations which prohibit this material from being placed in a sanitary landfill. This, in turn, has given rise to a demand for facilities to compost this material so that it can be used as a soil supplement.

A case in point is the yard waste composting facility operated

for the City of Rockford, Illinois by Laidlaw Waste Systems. During 1989, the State of Illinois enacted a regulation which prohibited the disposal of yard wastes in sanitary landfills effective July 1, 1990. In response to this, the City of Rockford applied for and received a permit to develop a yard waste composting facility. Laidlaw Waste Systems was subsequently contracted to design, construct and operate the facility.

During the spring of 1990, a 40 acre parcel of land was prepared for the compost facility. Site preparation work included diversion of storm water run-on, development of the internal drainage system, preparation of access roads, and construction of sedimentation and stormwater retention ponds.

The facility opened on July 1, 1990. Under contract with the City of Rockford, Laidlaw collects yard waste from approximately 150,000 residents and transports it to the compost facility.

Initial waste processing includes chipping of branches and grinding of leaves and small brush. Larger branches are segregated and offered as firewood to local residents. The processed material is combined with grass clippings and wood chips and is placed in windrows where it is turned approximately once each 10 days using a Scarab windrow turning composter. Moisture is added as necessary to promote the composting process. The composting process is completed in a period of 12 to 15 weeks. The product is screened to remove large particles which would make the material unacceptable for certain applications. Analysis of the product shows it to be very high in nutrient content. The supply of compost is far less than the demand for the product. The compost facility handles an average of 80 to 90 tonnes of yard waste per day during the growing season. The process achieves approximately 70% volume reduction. This facility has been very effective in diverting wastes which would have otherwise occupied a substantial volume of landfill space.

ALTERNATE DAILY COVER

Regulations for sanitary landfill operation typically require that a 150 millimeter layer of soil be applied to the top of the refuse on a daily basis in order to prevent blowing litter, control vermin burrowing and improve the appearance of the inactive working face. In many cases, placement of cover soil is poorly managed, resulting in a substantial reduction in disposal capacity within the landfill.

Many publications and technical guidance manuals indicate that a landfill will require one cubic meter of daily cover soil for each four to five cubic meters of compacted waste. This suggests that daily cover soil would occupy between 17 and 20 percent of the volume of a typical landfill. In fact, the daily cover occupies a much greater proportion of the volume in most landfills.

Although relatively little information is available in the literature, the author has observed that daily cover can range from 12 percent to 43 percent of the volume of a waste disposal site and typically occupies more than 25 percent of the total volume of a site. Since more space is occupied by daily cover soil, less volume is available for waste disposal. A number of management practices contribute to use of increased volumes of daily cover soil. The thickness of daily soil cover placement is generally controlled visually: a sufficient depth of soil is placed above the compacted waste so that none of the waste is visible. The thickness of soil will depend on the relative smoothness of upper layer of waste. Where the surface is smooth and contains few cavities and furrows, a 150 millimeter thickness of soil may be sufficient. Where little attention is paid to compacting and smoothing the surface before daily cover is placed, the necessary thickness of daily cover may exceed 300 millimeters. The nature of the cover soil used will also affect the quantity required to adequately isolate the waste. Sandy cover soils will tend to ravel and sift into voids, thereby increasing the volume of soil required.

In light of the diminishing disposal capacity available and the inefficiencies of daily cover placement, there is increasing interest in the use of alternate daily cover (ADC). A desirable alternate daily cover is a material which can accomplish the primary objectives of soil daily cover (litter control, vermin control, reduction of visual impact) while occupying less volume within the landfill. The volume saved is then available for waste disposal.

Many forms of alternate daily cover are available, some as generic products, others as proprietary products and application systems. To date, all of these materials fall into three broad categories.

SELECT WASTES These are generally materials with a soil-like consistency which are substituted for the soil which would otherwise be used as a daily cover. Examples include certain foundry sands, lightly contaminated soils and select dry, stabilized sludges.

SHEET AND FILM PRODUCTS These are products which are produced in panels or rolls. The material is placed and secured on top of the working face. The material may be left in place (in the case of films), or recovered before continuing disposal operations for subsequent reuse. Examples include tarpaulins, geotextiles and geomembranes.

FOAMS Foam products are produced by combining certain chemicals. The foam is applied by specialized equipment. Various proprietary systems are available.

Laidlaw Waste Systems has gained considerable experience in this area through numerous experiments with these materials. A project was recently initiated in Ottawa, Ontario to develop and assess a second-generation alternate daily cover. This program is described in the following paragraphs.

In developing an effective alternate daily cover, a number of factors must be optimized:

DURABILITY: The product must be able to withstand a broad range of climatic conditions throughout its intended life.

SIMPLE DEPLOYMENT: The material must be capable of being rapidly and efficiently installed in a broad range of weather conditions.

BENIGN OR BENEFICIAL TO THE LANDFILL: The product must not hinder the processes underway in the landfill (decomposition, movement of gas and leachate to control points, etc.). Any mechanism which would promote these processes would be considered a benefit.

COST: The overall cost to implement the alternate daily cover program should be reduced to the lowest practical amount consistent with achieving the objectives.

In order to optimize these parameters, Laidlaw Waste Systems entered into a joint venture agreement with a company involved in production of specialty plastics. The joint venture has the exclusive rights to a technology which produces rapidly biodegradable sheet and film products. The technology has the further benefit of being able to use in excess of 60% recycled plastic in the product formulation. This far exceeds the amount of recycled material which can be used by other sheet and film production processes (typically less than 10%).

The initial phase of the project involved specification of the sheet and film products to be used in prototype testing. These products were then manufactured and tested to verify that the material strength would be sufficient for the stresses anticipated during deployment and service. Samples of the products were subjected to leaching tests to verify that the material would not produce an unacceptable leachate in a

landfill environment. Additional specimens were then exposed to various environmental conditions to determine susceptibility to degradation and the impact of exposure to material properties.

The final component of Phase I of the study involved a short period of field deployment and subsequent observation and testing of the product. Various thicknesses of material was deployed at the landfill in late September of 1990. At that time, various deployment, anchoring and connection techniques were evaluated to guide in the development of prototype equipment for long term field trials of the product and deployment method.

Phase II of the program will involve evaluation of the Phase I data in order to select the most appropriate thickness of material and the field techniques for installing and securing the product. Prototype equipment will then be built, operated and refined in order to optimize the installation technique. Studies will be conducted to quantify the biodegradability of the material and to determine material properties over time under various circumstances.

Through the development of an appropriate product and refinement of installation techniques, it is expected that the effective volume of disposal capacity can be substantially increased using alternate daily cover material.

CONCLUSION

Given the increase in waste generation rates and the difficulty of creating new land disposal capacity, landfill capacity is being rapidly depleted. However, alternative management practices are available to use disposal capacity more effectively. Use of these techniques can prolong disposal site life while alternative waste disposal methods are being developed.

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Mr. Allard is a chemical engineering graduate from Queen's University in Kingston. He has ten years experience with the pulp and paper industry in research, development and manufacturing. For over fifteen years, he has worked with Environment Canada in the area of environmental protection.
His current position with Environment Canada is as Associate Director General, Environmental Protection. Mr. Allard has recently been involved in: finalizing the Canadian Environmental Protection Act (passed by Parliament in 1988); development of Canada's regulatory program to protect the ozone layer; development of regulations to eliminate lead from gasoline.

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Jim Barker is an Associate Professor in the Department of Earth Sciences, University of Waterloo. He is also Associate Director of the Waterloo Centre for Groundwater Research, located at Waterloo. This Centre is one of the Ontario Centres of Excellence supported by the Premier's Council through the Technology Fund of the Province of Ontario. Jim's research focuses on the behavior of organic contaminants in groundwater and their clean-up.

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Dick Connelly is President and Manager of R.W. Connelly Associates Inc. Consulting Engineers and Land Planners. He is also a principal in Cowater Municipal Services. His experiences include: project manager for servicing infrastructure including small bore sewers; sewage disposal system, well and piped water supply, water treatment and hydrogeological investigations, Maryland, USA; development of new cost-effective technology for municipal services for approval from state and provincial authorities, including financial management, public participation and user fees and educational programs; expert witness at OMB hearing; land planning, investigative studies; watershed management studies and feasibility studies for international and Third World countries for water and sanitation projects. He is a graduate of Queen's University, Kingston, Ont.

Mr. Blake Dawdy
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Blake is Senior Environmental Engineer with Northland Engineering. His activities cover most of the field of water resources engineering. His experience with septic system design and management includes major Private Services Funding programs in Field, the Township of East Ferris, the Town of Trout Creek and the design of numerous large systems. Since graduating with a Bachelor of Engineering from McMaster University, he has acquired experience and expertise in a number of fields including hydrology, erosion, water quality evaluation and remediation, municipal servicing, hydrogeology and landfill design. Highlights of his career to date include the Lake Nipissing Pollution Control Study and the Trout Lake Pollution Control Study. Both of these studies feature new and innovative approaches to age old problems.

Dr. Francois Fiessinger
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Francois Fiessinger was born and educated in France, receiving his doctorate in Environmental Engineering in 1975, and a Masters in Business Administration in 1977. He worked for the Societe Lyonnaise des Eaux in Paris, France, from 1972 to 1989, with the following responsibilities: water supply for the City of Creil, France; Head of Water Quality, Paris, France; Research Director at Le Pecq, France; Technical Director and Corporate Research Director, Paris, France. Since March, 1989, Francois has held the position of Vice-President at Zenon Environmental Inc. He is the current President of the Scientific and Technical Council of the International Water Supply Association, was the US A.E.E.P. distinguished lecturer for 1987. He is the author of more than 120 publications in scientific and technical journals.

Mr. Mel Fisher
Town Engineer
Dryden, Ontario

Mr. Fisher graduated from the University of Manitoba as mechanical engineer, in 1961. He is past-president of Dryden J.C.'s, and J.C.I. Senator, and a member of Dryden Rotary Club. Since 1977, Mr. Fisher has been Town Engineer of Dryden, Ontario, which owns and operates its own water and waste-water treatment plants and sanitary landfill. His past projects include design of Dryden's unique and very successful landfill, general contracting of many town projects including Canada's first indoor swimming pool incorporating solar heat in its original design. He has played a central role in the formation of the Northwest Ontario Recycling Association, of which he is presently Chairman of the Board. Mr. Fisher runs his 900 acre hobby farm in accordance with the dictum "I have been given this little piece of the earth to look after for a little while - I will leave it in better condition than I found it".

Mr. Pat Gillespie
Ministry of the Environment
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Mr. Gillespie started his career with E.B. Eddy Paper Mills in 1965. In 1967, he graduated as a civil technologist from Ryerson Polytechnical Institute in Toronto. He worked as operations technologist with the Ontario Water Resources Commission, from 1967 to 1972. Since 1972, Mr. Gillespie has been with the Ministry of the Environment. From 1972 to 1976 he served as Area Superintendent Water Pollution Control Plants and Water Treatment Plants, Sudbury, and since 1976 as Operations Officer, Utility Operations Section, Northeastern Region. He is a member of the Ontario Association of Certified Engineering Technicians and Technologists; past president of the Northeastern Ontario Water Works Association and member of the Board of Directors of the Northeastern Water Works Association.

Mr. Philip Joseph, P. Eng.
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Philip Joseph has worked for the OWRC/Ministry of the Environment for 23 years. For a majority of this time he was a Project Manager in Northern Ontario bringing sewer and water systems to many municipalities. For the last 5 years he headed the Land Use Planning and Noise Assessment Sections in the Approvals Branch. Currently he is a consultant for sustainable development projects.

Dr. Albert J. Liem
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Albert is a chemical engineer with Bachelor and Master degrees from the University of Queensland, Australia and a Doctorate from McMaster University in Hamilton, Ontario. He has been with the Alberta Environmental Centre (AEC) for 9 years, and is responsible for research and development in Air and Waste Management, in the areas of stabilization/solidification, incineration and biological processes. He was involved in the quality assurance aspect of the incinerator trial burns at the Alberta Special Waste Treatment Facility in Swan Hills. Prior to joining AEC, Albert was with Domtar Research Centre in Senneville, Quebec for 6 years, involved in air pollution abatement and recovery of spent Kraft liquor.

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Cultural Survival Institute
Ottawa, Ontario

Elizabeth May is an environmentalist, writer, activist, broadcaster, and lawyer. She first became heavily involved in environmental issues in the mid-70's, fighting insecticide spraying on forests near her home on Cape Breton Island, Nova Scotia. Elizabeth is a graduate of Dalhousie Law School. She has held the position of Associate General Council for the Public Interest Advocacy Centre, representing consumer, poverty, and environment groups in her work. In 1986, Elizabeth became Senior Policy Advisor to the then Federal Environment Minister, Tom McMillan. She was instrumental in creating several national parks, and in drafting new legislation and pollution control measures. In 1988, she resigned on a point of principle. Currently, Elizabeth May is Executive Director of Cultural Survival (Canada), an organization she established, which works globally with idigenous peoples on environmental issues, and National Representative for the Sierra Club of Canada. Elizabeth sits on various boards, is the recipient of several awards, has just released her latest book "Paradise Won: The Struggle to Save South Moresby", and maintains an active radio and television broadcasting career.

Mr. Gordon E. McGuinty
President
Notre Development Corporation

Gordon McGuinty is the President of NOTRE Development Corporation, a company whose management group has over 10 years of experience in the development of a similar solid waste project in Quebec. He was born in Dryden, Ontario and has made North Bay his home for 32 years. Gordon began his business career in the road building industry, working for Standard Paving Company for 10 years prior to beginning his own companies specializing in concrete construction, roadbuilding and aggregate production. His companies were involved in athletic construction in both Canada and the United States, during which time they purchased and operated a major athletic surfacing company in Columbus, Ohio. Currently, Mr. McGuinty is the President and owner of Delgordon Construction and Materials Ltd., a general contracting firm. He is also the owner of Christopher Gordon Associates Ltd. a management consulting company based in North Bay, specializing in small business development. Mr. McGuinty is a former member of the National Ski Team "Les Espoirs". During his 8 years as head coach and program director, he was directly responsible for the development of the Northern Ontario Ski Program. He is an active member of the North Bay Golf and Country Club.

Mr. George Mierzynski, P. Eng.
Director, Project Engineering Branch
Ministry of the Environment
Toronto, Ontario

In 1960, George graduated from the University of Toronto in civil engineering. He was located in Sault Ste. Marie for 3 years with the Ministry of Transportation and Communications as a project engineer, returning to Toronto in 1963 to work in the electronic computing field. In 1965 he joined the Ontario Water Resources Commission (OWRC) as a construction engineer and was appointed supervisor in Project Coordination Branch in 1970. Since that time he has held the positions of Chief Engineer and Assistant Director of the Project Coordination Branch, Project Director for the Ontario Waste Management Corporation, Director of Central Region for the Ministry of the Environment and is currently the Director of the Project Engineering Branch, M.O.E. He is a member of A.P.E.O., P.C.A.O., AWWA (Ontario Section) and past chairman of the AWWA (Ontario Section).

Mr. Frank Moir, P. Eng.
Proctor & Redfern
Toronto, Ontario

Frank Moir is Vice-President of Water and Wastewater at Proctor and Redfern Limited. During his twenty-three years with the firm, he has been involved in a broad range of projects in the Water and Wastewater fields. He has held management positions in several regional offices in Canada and abroad including three years in Sault Ste. Marie in the 1970's. He is currently responsible for five technical groups, namely, water supply, municipal wastewater, industrial wastewater, hydrotechnical and laboratory services. Frank is a graduate of the University of Glasgow.

Mr. Edward W. Piche
Ministry of the Environment
Toronto, Ontario

Edward Piche was appointed Director of the M.O.E. Air Resources Branch in 1986. His responsibilities include: Air Quality and Meteorology, Emission Technology and Regulation Development, Atmospheric Research and Special Program and Phytotoxicology.

In 1975, Mr. Piche joined the Ontario Ministry of the Environment as an Air Quality Analyst in Sudbury and since that time has held progressively responsible positions. He became Coordinator of the Sudbury Environmental Study later in 1975, and the Coordinator of the Acidic Precipitation in Ontario Study in 1979. In 1983, Edward Piche became the Assistant Director of the Hazardous Contaminants and Standards Branch and later that same year he was appointed Acting Director. Mr. Piche became Chairman of the Ministry's Research Advisory Committee in 1985.

From 1972 - 1974, Mr. Piche was lecturer and Environmental Studies Coordinator with the physics Department of Laurentian University. He has prepared and presented over forty papers and publications. Mr. Piche holds an M.Sc. (Physics) from Laurentian University.

Mr. Ronald J. Poland, P. E.
Laidlaw Waste Systems
Burlington, Ontario

Since March, 1989, Mr. Poland has been Vice-President Environmental Management, with Laidlaw Waste Systems. Prior to Laidlaw, (May, 1980 to March 1989) Ron worked with Waste Management Inc., Oak Brook, Illinois, in the positions of Regional Engineer/District Engineer; Manager, Environmental Studies and Design; and Director, Environmental Management and Engineering. From 1977 to 1980, he was employed as a Project Engineer with Marshall, Macklin, Monoghan Ltd. He has a B.A. Sc. and M.A. Sc. from the University of Waterloo, and M. Eng. from the University of Toronto. Ron is registered as a professional engineer with the Province of Ontario; a past member of the Task Force on Waste Disposal for the National Research Council of Canada; past chairman, Sanitary Landfill Task Committee, American Society of Civil Engineers; and past member, Board of Governors, Geosynthetic Research Institute, Drexel University. He has many technical publications to his credit.

Ms. Diane Radnoff
Gartner Lee Ltd.
Markham, Ontario

Diane Radnoff, P. Eng. has a B.Sc. in Chemical Engineering from Queen's University, Kingston, Ontario. She is in the process of completing a Masters of Engineering at the University of Toronto, in Industrial Hygiene.

Ms. Radnoff gained considerable experience with wastewater treatment technologies for the treatment of landfill leachates and industrial wastes while working on contract for Environment Canada. She has continued to apply this experience to remediation programs in the last year while employed by Gartner Lee Ltd., Markham, Ontario.

Dr. Anthony Redpath
Consultant
Toronto, Ontario

Dr. Redpath is an environmental consultant specializing in plastics waste management, particularly degradable plastics. He obtained a Ph.D. in Chemistry from the University of Toronto in 1976 and subsequently worked as a research associate at institutes in West Berlin and Toronto. He joined EcoPlastics Limited in 1982, becoming its president in 1985. He has worked extensively on the development and commercialization of EcoPlastics' Ecolyte degradable plastics technology. He is currently a consultant to EcoPlastics, as well as to the commercial suppliers of Ecolyte, Enviromer Enterprises and Ecolyte Atlantic. Dr. Redpath has received several scholarships during his career, including the Lieutenant Governor's Gold Medal in Science at the University of Alberta, a Natural Sciences and Engineering Research Council (NSERC) Centennial Scholarship during his Ph.D. work and an NSERC Industrial Research Fellowship tenable at EcoPlastics. He is the author of over twenty scientific publications and has two patents.

Mr. Douglas Scott
Proctor & Redfern Limited
Thunder Bay, Ontario

Douglas Scott is the Chairman of Proctor & Redfern Limited and Vice-President responsible for the firm's Northern Ontario operations. The firm is widely recognized for its expertise in municipal engineering, solid and hazardous waste, transportation, land development and building services. Mr. Scott is a graduate in Civil Engineering from the University of Toronto and is a designated consulting engineer in the municipal engineering field. Over the last 25 years, his career has been based on municipal engineering projects for many municipalities in Northern Ontario. His office presently acts as Town Engineer for Sioux Lookout, Red Lake, Marathon and Beardmore. Aside from his professional background, Mr. Scott has served as a Commissioner for the Local Government Study for the municipalities of Kenora, Jaffray Melick and Keewatin. He is a past president of the Thunder Bay and Northwestern Ontario Associated Chambers of Commerce. He is currently Resources Committee Chairman for NOACC and First Vice-President of the McKellar General Hospital Board of Governors. In 1988, Mr. Scott was presented with the Executive of the Year Award by the Northern Ontario Business Foundation.

Mr. Arne Sorenson
Northern Ontario Heritage Fund Corporation
Sudbury, Ontario

Mr. Sorenson has 25 years Senior Management experience with private sector resource related industries in Western Canada and the Canadian Arctic. He served for 5 years as Vice-President of a major Canadian industrial and commercial land development company. For 14 years, Mr. Sorenson worked for the government of Ontario as Director of the Eastern Ontario Development Corporation and Northern Ontario Development Corporation. From its inception in 1988, to the present, Mr. Sorenson has held the position of General Manager, Northern Ontario Heritage Fund Corporation.

Mr. David R. Turnbull, P. Eng.
International Water Supply Ltd.
Barrie, Ontario

David R. Turnbull graduated from Queen's University in Kingston, Ontario in 1959 with a B. Sc. in mechanical engineering.
Since 1972, he has held the position of Vice-President and Director of International Water Supply. Prior to that, he held the positions of District Engineer, Assistant District Engineer and Field Technician with this firm. David is affiliated with the Association of Professional Engineers of Ontario, the Engineering Institute of Canada, the American Water Works Association, the Association of Consulting Engineers of Canada and the National Water Well Association. He has published numerous papers on aspects of groundwater investigation, and development and maintenance of wells. He has presented on groundwater topics for Layne Associates, American Water Works Association and Ontario Water Resources Commission. David's experience ranges from groundwater investigation programs, geophysical surveys, aquifer analysis, well field design, dewatering, production well design, well rehabilitation, and water treatment plant design to pumphouse design.

Ms. Merilyn Twiss
Ministry of Natural Resources
Sudbury, Ontario

Merilyn graduated from the University of Guelph with an Honours B. Sc., specializing in Wildlife Biology. Following graduation, she was employed by the Wildlife Branch of the Ontario Ministry of Natural Resources (O.M.N.R.) to work on the Lakeshore Capacity Study, assessing the impact of cottage development on wildlife and wildlife habitat. This was followed by a contract with the Wildlife Research section of O.M.N.R., where she worked on the moose research program. In 1977, Merilyn accepted a position with the Northeastern Regional Office of O.M.N.R. as Regional Project Biologist. She then transferred to North Bay District in 1980, first as District Biologist and later as the District Wildlife Biologist. She has participated in many planning initiatives including the Strategic Land Use Plan for Northeastern Ontario, the District Land Use Guidelines for North Bay District, the North Bay District Fisheries Management Plan, individual lake management plans, district timber management plans, a management plan for the Loring deer herd and review of many individual development proposals. Her field projects this summer included wetlands evaluation projects, a loon reproduction study, a raptor survey, and an amphibian and reptile survey.

Mr. William R. Walker, P. Eng.
Walker Engineering
Sault Ste. Marie, Ontario

Bill Walker was educated at the University of Canterbury, New Zealand and is a registered Professional Engineer in the Province of Ontario. He is President of Wm. R. Walker Engineering Inc., Consulting Engineers and Planners, and provides consulting services in the areas of urban development, water supply, sanitation, and urban planning to private and government clients throughout the Canadian International Development Agency. He has a particular interest in third world development issues and has been involved in development projects in Afghanistan, Indonesia, St. Vincent, and Dominica.

ACKNOWLEDGEMENTS

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Dr. Mike Moselhy, Program Committee Chairperson, it is through your efforts that such an interesting and worthwhile agenda was put together for this conference. Your expertise and help in all phases of the conference helped to ensure its success.

Mrs. Carey Thompson, Conference Coordinator, we thank you for the many long hours you have put in overseeing all aspects of this conference. You have once again coordinated a successful, to-be-remembered event.

The Media Services of Sault College printed the brochures and signage and publication of proceedings. They sent out news releases, coordinated press coverage provided liaison with government offices. Their professional services were very much appreciated.

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INNOVATIVE TECHNOLOGY TRANSFER CONFERENCE

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The following organizations set up displays at the conference. We thank them for their time and enthusiasm.

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